

ANALOG

A vibrant science fiction illustration featuring three futuristic spacecraft. A large, sleek ship with orange and blue details is positioned in the upper right. Two smaller, more rounded ships with similar color schemes are in the lower left and bottom right, both emitting bright orange energy trails. The background is a deep blue sky with wispy white clouds and a small blue planet visible in the upper center.

SCIENCE FICTION AND FACT

Alec Nevala-Lee
Edward M. Lerner

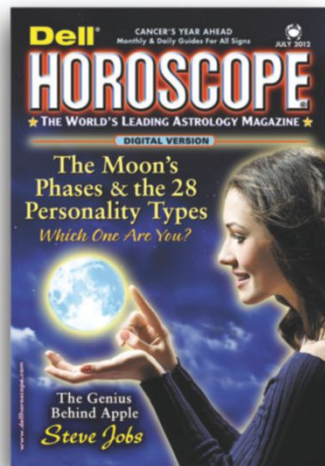
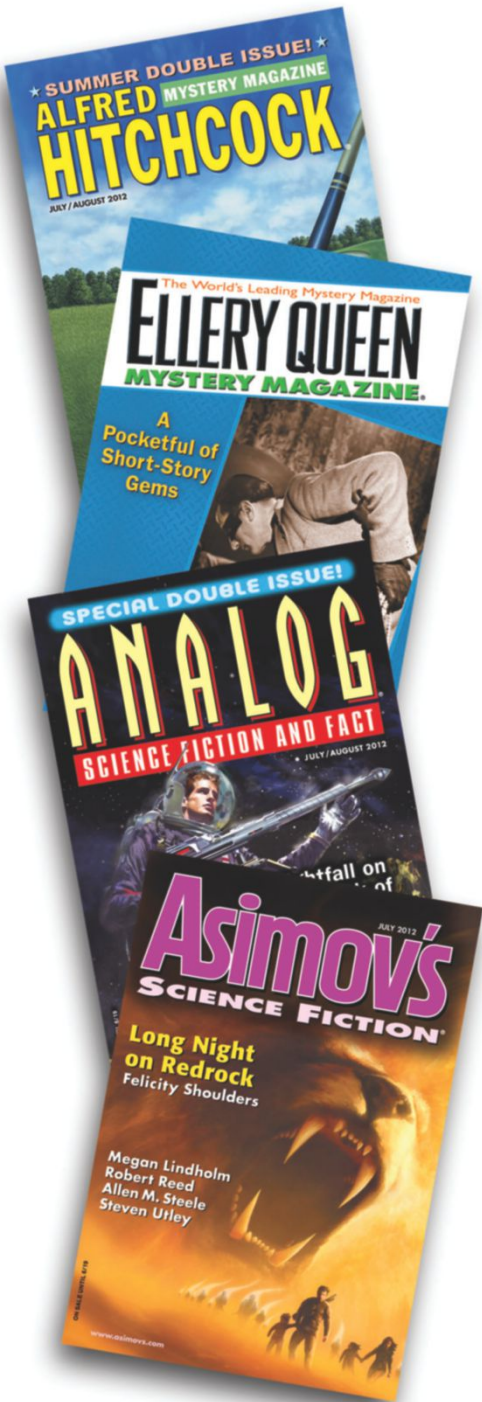
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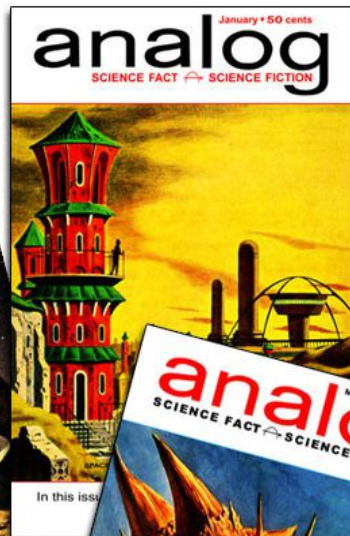
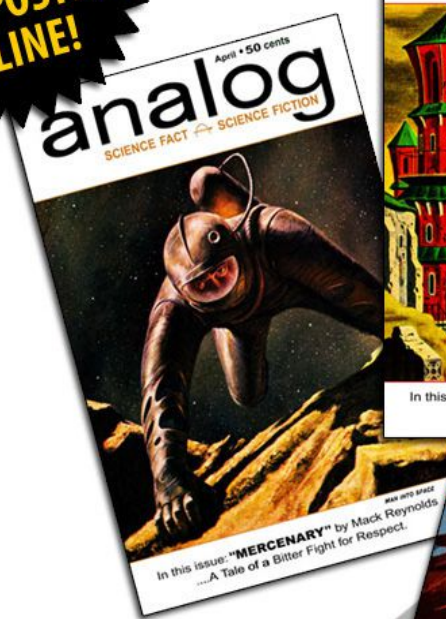
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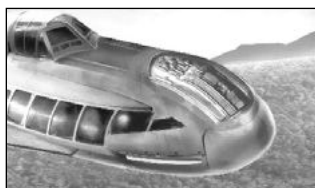
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AD ASTRA! INTERSTELLAR TRAVEL IN SCIENCE FICTION (PART 1)

In 1634, Johannes Kepler published *Somnium*, arguably the first science fiction book. In this story, the protagonist is transported to the Moon where he encounters life forms engaged in a variety of activities. Subsequent authors who wrote about space travel (e.g., Jules Verne, H.G. Wells, Edgar Rice Burroughs) also focused on our Solar System; particularly the Moon, Mars, and Venus. However, after the turn of the twentieth century, articles involving spaceships traveling to distant stars were written by prominent scientists and engineers such as Robert Goddard, Konstantin Tsiolkovsky, and John Desmond Bernal. In 1928, E. E. “Doc” Smith published the first of his many space operas entitled *The Skylark of Space*, which describes the interstellar adventures of its protagonist as he travels through the cosmos in his faster-than-light ship.

Here I will focus on the history of interstellar travel in science fiction over the last three quarters of the twentieth century. Part two (which will appear in the November *Analog*) will deal with the year 2000 until today. As criteria for discussion in this column, stories must include a starship transporting people to a distant stellar destination,¹ and the normal laws of physics must apply for the method of propulsion (sorry, no faster-than-light ships or warp drives!). I will employ the useful classification outlined by Simon Caroti in his 2011 book *The Generation Starship in Science Fiction: A Critical History, 1934–2001*, in order to delineate important trends in the interstellar literature.

The Gernsback Era

The first of Caroti’s periods is the Gernsback

era (1926–1940), named for Hugo Gernsback, editor of the first English language science fiction pulp magazine, *Amazing Stories*. He also edited *Wonder Stories*, where in September 1934 a multigenerational starship narrative written by Laurence Manning appeared entitled “The Living Galaxy.” In this story, humans are able to undertake multi-million-year starship missions thanks to an anti-aging procedure. Twelve scientists and their leader convert an uninhabited asteroid into a multigenerational starship and undertake a four-million-year mission to confront a monstrous, living, intelligent assemblage of galaxies that’s devouring matter in the cosmos through its huge stellar tentacle. The staggering temporal and spatial dimensions in this story superbly illustrate the presence of the science-fictional “sublime.” However, relatively little is said in Manning’s story about the psychological and sociological problems experienced by the crew as they travel into the lonely outer reaches of space. Instead, they are pictured as vigorous and inventive, with no major personality or interpersonal difficulties.

A less ambitious story takes place in Don Wilcox’s “The Voyage that Lasted 600 Years,” which appeared in *Amazing Stories* in October 1940. Here, the crewmembers have a normal life span and undergo a mission to colonize planets around a star named Robinello. A person called the Keeper of the Traditions is put into hibernation and awakened every one hundred years to educate succeeding starship generations about the purpose and goals set forth by the original mission planners. However, his infrequent lessons prove ineffective, and over time the crew

¹ By this criterion, some excellent books depicting world-like societies in space are excluded, such as Larry Niven’s *Ringworld* (1970); Stanley Schmidt’s *The Sins of the Fathers* (1976) and *Lifeboat Earth* (1978); and the four parts of Gene Wolfe’s *The Book of the Long Sun* (1993–1996).

² For more on this and other novums in SF, see I. Csicsery-Ronay’s *The Seven Beauties of Science Fiction* (2008).

culture devolves into a condition of social decay and loss of technological know-how, with disease and instability plaguing the population. The story describes the tension between these events and the Keeper's attempt to correct matters.

Stories of the Gernsback era reflected traditional American values involving good guys and bad guys and formulaic plot lines. They offered a relatively inexpensive escape from the stresses and strains of the Depression. Science fiction was seen as a guide for a better future that promoted values in accordance with the tastes of its largely young male readership.

The Campbell Era

During the Campbell era (1937-1949), when John W. Campbell, Jr., took over the editorship of *Astounding Stories* magazine and renamed it *Astounding Science Fiction*, science fiction stories became attuned to real human concerns, reflecting the turbulent international scene leading up to and including World War II. There was also more demand for scientific plausibility and better storytelling. These trends are illustrated in two related stories by Robert A. Heinlein, "Universe" and "Common Sense," which were originally published in *Astounding Science Fiction* in May and October 1941, respectively. They have since been combined and are available today as *Orphans of the Sky*. Together, they represent the first novel-length tale about a multigenerational starship.

The action takes place on board a giant interstellar vessel whose inhabitants have forgotten the purpose and nature of their mission due to a long-ago mutiny. Most are illiterate farmers living in a pre-technological culture marked by superstition and a belief that the ship is the entire Universe. They periodically must defend themselves against a group of mutants that occupies the upper decks of the giant ship. The protagonist

learns the secret of the interstellar mission from the mutants, and, partnered with the two-headed mutant leader, rebels against the ruling oligarchy. Throughout, Heinlein concerns himself with the emotions of all the inhabitants and with issues related to the sociology of the culture. He describes features of the multigenerational ship in vivid terms and reveals aspects of the plot through the actions of the characters rather than relying on info-dump statements.

The Birth of the Space Age

Caroti characterizes his next era, The Birth of the Space Age (1946-1957), as a time when the notion of technology producing a better future was combined with Cold War fears of a dangerous present. The number of starship stories increased. Some of the previous era's storylines were continued, but with better descriptions of technological features, concerns with the psychological well-being of the starship inhabitants, and attention to ecology, (e.g., using hydroponic systems for the food supply).

Frank M. Robinson's novella "The Oceans are Wide," (*Science Stories*, April 1954) concerns a multigenerational starship mission governed by a hereditary board of executives whose dying chairman is supposed to be succeeded by his son. Unfortunately, the son is ill equipped to take over due to his less aggressive personality and the scheming of competitive family members. With the help of a Machiavellian-like Predict, the son grows up to become the chairman, and the ship successfully reaches its destination. Outwitting his mentor, the protagonist himself became the new Predict. In this story, the tensions and nuclear fears of a Cold War are front and center in the rationale for the mission and the justification to create a better society on the new planet. Ecological concerns

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also are part of the story line. Life on board the ship is clearly described, including recreational activities, the intrigues of governance, and the need for population control.

The New Wave Era

Science fiction changed dramatically during Caroti's New Wave era (1957–1979). The launch of Sputnik, Viet Nam War protests, the rise of feminism, and the hippie generation dethroned traditional male American values as the only acceptable blueprint for the future. Science fiction expanded into venues beyond pulp magazine stories, such as television, movies, and board games. A number of sub-genres emerged, such as feminist and young adult science fiction and science fantasy, and traditional “hard” science fiction itself became a sub-genre.

These trends affected interstellar travel stories as well. According to Caroti, some two dozen multigenerational starship narratives appeared during this era, about ten times that of the Gernsback period and double the frequency of the Campbell era.³

An example of the above trends is found in British writer Brian Aldiss' novel *Non-Stop*, originally published in 1958. The story begins like a typical forgotten-mission multigenerational story. The protagonist is a member of a primordial tribe living in a primitive jungle-like setting.

While exploring the environment, he and his colleagues encounter a more sophisticated tribe and learn that they are on a multigenerational starship whose inhabitants are returning from a planet around the star Procyon, where they had suffered from a pandemic some 23 generations earlier. As they explore further, they learn a number of additional facts that change their entire outlook of the mission. Aldiss addresses a number of New Wave themes in this novel, such as biological issues related to the environment and psychoanalytic theories and terminology to describe the interactions of the inhabitants.

Hard science fiction could also be found during this period. Groups such as the British Interplanetary Society showed interest in propulsion systems to send people to the stars, and some science fiction stories revolved around this interest. In Joe Haldeman's Hugo Award-winning short story “Tricentennial” (*Analog*, July 1976), scientists located in a space colony at the stable L-5 Earth-Moon Lagrangian Point have intercepted broadcasts from the star 61 Cygni eleven light years away. To investigate, they develop a plan to build a starship powered by reconverted hydrogen bombs. However, the public does not support the mission, fearing that any aliens discovered would be hostile. Years later, the L-5 scientists propose a shorter mission to collect antimatter from one of a pair

³ Caroti, S. (2011), p. 201.

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of small black dwarfs at the edge of the Solar System. Disguised as a celebration of America's Tricentennial, the mission is approved. But the scientists plan to modify the engines en route and continue on to 61 Cygni, and their subsequent adventures complete the story. Using lively dialogue, colorful characters, a clever way of telling the story that moves us back and forth in time, and contemporary ideas involving interstellar propulsion and time dilation at near-light speed, this gem of a story is hard science fiction at its best.

Another excellent hard science fiction short story, written a few years later, is Gregory Benford's "Redeemer," (*Analog*, April 1979). A man traveling in a very fast spaceship intercepts a slower interstellar starship launched 75 years earlier that is headed for Tau Ceti. The slower ship uses an older propulsion system that enables it to travel at slightly less than 10% light speed. This ship contains many thousands of future colonists in suspended animation, a cache of frozen DNA that will be used to supplement the colony's genetic pool, and three people who have been awakened for a five-year tour of duty monitoring the ship. The man in the faster ship plans to hijack the DNA and take it back to the Solar System in order to replenish radiation-damaged DNA resulting from a devastating war. The plot is thoughtful and takes unexpected twists, such as the man finding that one of the awake crewmembers is his great-grandmother!

The Information Age

Caroti's final era is the Information Age (1980–2001). Science fiction once again took on a technological character, partly due to the growth of computers and smart phones—but this was of a more personal and intimate nature. A new group of technologically savvy writers promoted novel ideas such as cyberpunk and nanotechnology. These trends worked against multigenerational starship stories with their large vessels, lofty goals, and faraway destinations. Caroti states that only seven multigenerational starship narratives appeared between 1980 and 2000.⁵

A nice example of a story from this period is Bruce Sterling's novella "Taklamakan" (*Asimov's*, October/November 1998). Two spy protagonists use digital camouflage suits, biotechnological mission gear (e.g., gelbrain cameras, enzyme-driven drills running on sugar energy), and information-seeking equipment to locate a mysterious base

buried under a Chinese desert by an Asian consortium superpower. They discover a facility built to support an interstellar mission simulation experiment. It contains three starship analogs inhabited by thousands of people considered undesirable by their government. When the people from one of the ships try to escape, they're attacked by a swarm of self-replicating biotech robots and are reimprisoned. The robots subsequently break through to the surface, revealing the horror of the underground prison to the people above.

The epitome of computer tech stories is Greg Egan's novel *Diaspora*, first published in 1998. This far-reaching and creative tale begins in 2975 and spans more than two millennia. Humanity has evolved into three major categories: citizens (units of sentient computer software operating within reality-based virtual communities called polises); gleisners (units of sentient hardware that reside in physical robot bodies and interact with the world in real time); and fleshers (humans that remain flesh and blood but can modify their genes to adapt to many environments). After an unexpected collision of two neutron stars in deep space, the resulting gamma ray storm reaches Earth and wipes out most of the fleshers. The gleisners and citizens decide to undertake interstellar travel to learn more about the Universe and discover what went wrong to cause the burster episode. The diaspora of the title refers to the actions of the citizens of one polis to clone themselves and send each clone to one of a thousand stars. Egan deals with new concepts and his own unique physics in this creative story published near the end of the 1990s.

New trends began to emerge in the interstellar literature in the twenty-first century, as we shall see in the November *Analog*. ■

Dr. Kanas is a Professor Emeritus (Psychiatry) at the University of California, San Francisco. He has been a NASA-funded researcher and has studied psychosocial issues affecting astronauts in space. He has written two books on the history of celestial cartography (*Star Maps and Solar System Maps*), published articles in *Analog*, and written two science fiction novels (*The New Martians* and *The Protos Mandate*), with a third novel (*The Network*) on its way. He can be found on the web at nickkanas.com and on Twitter @nick_kanas.



Illustrated by Kurt Huggins

Stonebrood

Alec Nevala-Lee

W**I.**hen Marius was out in the field, his thoughts often turned to the day the earth caved in. He had not been there to see it, but he remembered every victim, and whenever he felt overwhelmed by the challenges ahead, he repeated their names to himself as a reminder of the human cost. One woman in particular stood out in his imagination, and although he had never met her, he sometimes caught himself telling the story of what her last moments alive might have been like.

She had been a single mother in her late twenties with an open, friendly face that he only knew from studying her headshot in the papers. That evening, she had been driving west on the highway that ran the length of Schuylkill County, keeping one eye on the clock on the dashboard. She worked after-noon and overnight hours at two different coffee shops, with a third stint on the week-end, and now she was afraid that she would be late for her graveyard shift in Frackville.

Perhaps she had been tired. Even when her parents were available to watch her son,

she rarely had a chance to sleep more than five hours at a stretch, and her schedule was packed to breaking. On most days, the drive to her second job took no more than twenty minutes, but tonight the traffic was inching along, and she was on the point of pulling out her phone to call her supervisor when she saw a white wall of smoke drifting across the two lanes ahead.

She decelerated instinctively and switched on her headlights. Along this stretch of road, the cars had slowed but were still moving. As she neared the fog bank, she had enough time to notice that it was strangely isolated, with the trees along the highway unobscured to either side. And she was almost at the cloud when the car in front of her, a little hatchback she had been following for the last few miles, simply disappeared, falling out of sight into the ground.

Her foot hit the brake. Behind her, she heard other cars screech to a halt, followed by the crunch of fenders colliding. Through her windshield, she saw the wave of fog advancing and a widening circle of crumbling asphalt along its leading edge—the cracks appearing and spreading on the surface of the road as a low vibration welled up through her tires.

Then the highway collapsed. Chunks of the gray paving cracked and broke off, fragmenting and toppling in wedges five feet across, and, before she could react, the hood of her vehicle tilted downward, swallowed up by the sinkhole that had covered the distance to her car in seconds. The view through her windows was erased by the smoke, and then she plummeted.

She was caught by her safety belt as her airbag engaged. The car slid off the surface of the highway and crashed ten feet below, the headlights winking out as the nose crumpled under the impact. She clutched the wheel, shocked, feeling a series of reverberations as more hunks of asphalt tumbled around her. It was only when the noise subsided that she realized she was gently sinking—the car and the fragments of the highway slowly settling into the soft mud.

Around her, the air was thick with vapor, but through the lights of a car that had landed with its headlamps on, she could make out a few other vehicles. The hatchback from

before lay at an angle, and, as she watched, a man emerged from the driver's side, trying for a foothold in the muck. She undid her seatbelt with shaking fingers and unlocked her own door, but when she tried to open it, it refused to budge. Putting her shoulder into the handle, she managed to open it a crack, pushing it through the mud that had already risen above the level of the chassis.

The smell hit her first. It was sulfurous, like a noseful of bad eggs, and it made her gag. Looking up at the sky through the gaps in the fog, she forced herself to keep going, squeezing through the single foot of space between the door and the frame. Only after she was out of the car, the rim of the sinkhole just inches out of reach, did she understand her mistake.

She saw the man at the hatchback collapse in a faint as her own head began to spin. Perhaps she tried to crawl back into her car, but instead she fell to her knees in the mire, feeling the soft mud between her fingers. She would have lost consciousness within fifteen seconds, and her last thought, or one of them, would have been that the mud was very hot.

By the time rescue vehicles arrived, it was too late. Hers was one of the first bodies to be retrieved, her features flushed and oddly lifelike. The total came to eight dead, all from carbon monoxide poisoning, on an ordinary stretch of highway a few miles north of Perry Township, Pennsylvania.

Marius knew precisely how they had died, and his only consolation was that they had felt no pain. More than three months after the disaster, he found himself reflecting on it all over again, looking into the mouth of a much smaller hole a mile from where the sinkhole had appeared.

The hole in question was a metal pipe, about six inches across, that had been set into a wellhead in the ground. Above it stood a tripod from which a taut white cable descended into the borehole. It snaked through a sheave wheel to the motorized winch that Marius was operating now, his hand resting on the manual brake as he reeled in the probe that had been taking readings three hundred feet below.

He was seated before a computer monitor mounted to a second tripod, its legs secured

to a wooden pallet with tiedown straps. A man named Vincent Lucas stood by the borehole, wearing a pink respirator and an orange jumpsuit, monitoring the tension in the line. Lucas was pale and quiet, but he had shown a special aptitude for this work, and Marius had asked for him to be assigned here. It was a demanding job under any conditions, and particularly in this kind of environment.

Whenever Marius glanced up to take in his surroundings, he saw a hellish landscape blanketed in the bonelike remains of dead trees and the smoke drifting up from the vents in the ground. Through the pallet, the earth was noticeably warm. Despite his own respirator, the smell of sulfur had given him a headache, and he was glad to have an absorbing task to distract him from it.

A second later, the winch hauled up the last of the cable, and the probe emerged from the borehole attached to a long metal joint at the end of the line. As Lucas fished it out, Marius turned off the winch and noted the depth reading at the surface. Then he gave Lucas a nod. "You can power it down."

Lucas nodded back. As the other man unhooked the probe, Marius headed for a white tent pitched twenty yards away—close to where they had parked the jeeps. Lifting the flap, he ducked his head and went inside where Ben Elkies was seated at a folding table and chair. "We're all set. Looks like the hole came through a chamber thirty feet from the fire area—"

Elkies raised a hand without looking up. "Not right now. Give me a minute."

Marius knew better than to be offended. He had spent much of his life dealing with spiky personalities, and he had brought in Elkies with full knowledge that the partnership would not be an easy one. Elkies was slender but intense, ten years younger and a full head shorter than Marius, and, although he could come off as abrupt or worse, this was only a sign of his exceptional concentration.

Without crowding Elkies, Marius examined what the graduate student was studying. It was a tiny mechanical drone, no larger than a housefly, hovering softly above the

table, where it was tethered to a power pack by a fine metal filament. Marius was familiar with the technology, but it did most of its work underground, so he had rarely been afforded a chance to see it in action.

The drone was misleadingly delicate in appearance, with a pyramid of four slender legs attached to a slim thorax of carbon fiber. At the moment, its wings, made of polymer film, were moving too fast to be seen, beating one hundred and twenty times per second. Marius heard a soft insectile hum as the drone executed a lateral move, floating six inches to one side before returning to where it had started.

Elkies switched off the power, sending the drone tumbling to the tabletop. He picked it up with tweezers and detached the tether. "I had to do a spot check. They're holding up well under the circumstances."

A white cylinder with a tapering base had been set up nearby on the table. Unscrewing the top of the hive, he pulled out the core, on which row after row of identical drones—eight hundred in all—were lined up like corn kernels on a cob. Elkies slotted the remaining drone into position and lowered the core back inside. Then he screwed on the top and rose. "Let's do it."

Without being asked, Marius picked up the hard case of equipment from next to the chair. Putting on his own respirator, Elkies followed Marius outside, the hive cradled under one arm.

At the borehole, Lucas was still powering down the transponder. Elkies paused for a second at the entrance to the tent. "I'll admit that I wasn't sure what to expect when they said they'd be using convict crews, but they work as hard as anyone else here. Maybe harder."

Marius followed his eyes to Lucas. "You shouldn't be surprised. These are nonviolent offenders. We're out with them in the woods, cutting fire lines with chainsaws. It doesn't work if you don't trust them."

Elkies adjusted his respirator straps with his free hand. "You work with them a lot?"

"You could say that. I used to be one." Seeing that the other man was about to apologize, Marius cut him off. "It's no secret. And it was a long time ago. But I've met a lot of guys like this. I grew up ten miles from here.

And I know you can't tell anything about them at first glance."

Even as he said this, Marius wondered if part of him had revealed this fact to make a point to Elkie, who had not been the warmest of companions. He indicated the borehole. "Come on. The others will be waiting."

By now, after six days in the field, they had everything down to a routine. As Marius checked the generator, Elkie assembled his equipment on the pallet and powered up a rugged laptop, which was connected by a wireless access point to the data center at the fire camp at the edge of the impact zone. After swapping in a new winch, they suspended the hive from the tripod, ready to lower it down.

Lucas took up position at the wellhead, keeping an eye on the line, as Marius zeroed out the depth indicator and powered up the winch. A minute later, the hive was descending into the borehole with Elkie stationed at the monitor that would receive updates as they came in. Marius cleared his throat. "I've been getting an earful from Boise. They want to know how much longer—"

Elkie gestured impatiently for silence. Marius obliged, aware that this was a crucial part of the process. As he stepped back from the pallet onto the ground, he could feel the heat coming up through the soles of his boots.

The coal seam fire under their feet had been raging for close to fifty years. It had been kindled, as far as anyone knew, on the outskirts of Perry Township at the heart of anthracite coal country. The most widely held theory was that residents had been burning garbage in a landfill in an abandoned mine outside town, and through an unsealed opening, the fire had entered a vein of coal, surging from there into a wild honeycomb of subterranean tunnels and chambers.

Like all coal fires, it had smoldered quietly, rarely flaring, its presence indicated only by its fumes and the sinkholes that appeared when a seam of coal subsided. After running the numbers, the state had decided that it was cheaper to evacuate the town and let the fire burn out, even if it took another two centuries. In the end, five hundred homes

had been demolished. Marius had taken readings in the shadows of the few remaining buildings and the old Lithuanian church, and he could see why such places had inspired so many ghost stories.

As Marius looked at the cable hanging into the borehole, he found himself astounded once again by the negligence on all sides. The fire had been ignored, with no systematic study attempted for more than twenty years, as it spread through an unsurveyed network of chambers and drainage tunnels, crisscrossed by the bootleg mines that residents had dug for their household furnaces. Nobody had any real idea of how big the fire was or where it was burning, and, without an adequate map, there was no hope of putting it out. One stray hot spot could undo it all.

A month ago, on a cold night allowing for maximum contrast, they had conducted a fly-over with an infrared camera, but Marius had still been haunted by the gaps in the data. When he read about Elkie, he knew that he had his answer. Released from the hive, the drones could go anywhere, mapping every corner short of a direct flame. It was expensive, but after the collapse of the highway, the political will was finally there. And the confluence of factors that had allowed his company to hire Elkie had presented him with an even greater opportunity.

Looking up, he saw Lucas signaling that the cable had grown slack. Marius turned off the winch and checked the display, which indicated that the hive had reached the floor of the chamber. Elkie was bending over the same readout. "Beautiful. I'm heading back. Once the data comes in—"

Marius had heard all this before. "We don't touch anything. You've got my number. We'll keep an eye on things here."

"Then I'll see you in six hours." Rising to his feet, Elkie began to head for the jeep. He paused. "I haven't forgotten about Boise. You can tell your team that we'll be ready tomorrow."

Marius only gave a thumbs up, trying to conceal his excitement. He watched as Elkie drove off toward the fire camp, from which he would monitor this hive and the five others that had been positioned throughout the impact zone. Then he went to help Lucas pack up the probe equipment.

The survey itself had been difficult—with more boreholes drilled each day as Elkies refined the map—but it was nothing compared to the next phase. An army of workers had been moving in machinery and equipment in parallel with the observations, and many of the parties involved were anxious to get started. Firefighting, as Marius had learned first in Pennsylvania and then in Texas, was as much a human problem as an environmental and logistical one, and he had long since lost track of the web of negotiations that had been required to get even this far.

Marius saw the terminal by the borehole blink into life. Leaving Lucas by the wellhead, he went over to study the monitor, where a spike had appeared on a graph. It indicated that the first sortie had begun, with a wave of drones emerging to spread throughout the darkness. Each drone could fly for ten minutes, after which it returned to the inductive charger in the hive to power up before being dispatched again. All told, there would be time for ten to twelve sorties before the hive had to be pulled up, cleaned, and reset for the next day's round of readings.

The resulting map, as the drones recorded the temperature and pressure in every crevice, was nearly complete, although Elkies had repeatedly pushed back the timeline. Marius sometimes wondered if Elkies knew how much was riding on this moment, toward which he and so many others had worked for years. But whenever he felt his own energy failing, he only had to think of the sinkhole to the north and the eight lives that had been lost there for no good reason.

Marius was repeating the names of the dead once more when Lucas straightened up at the borehole. His voice was muffled by the respirator, but it was still clear in the silence. "*Bicilyste.*"

It was the first time he had spoken in hours, and, at first, Marius wasn't sure that he had heard him correctly. He turned to the member of the convict crew, his thoughts contracting to a single point. "What did you say?"

"*Bicilyste.*" Lucas stared back at him, his eyes wide. "The kinship of bees."

Marius suddenly became aware of how alone they were. None of the other workers

or boreholes were in sight, and the land around them was as empty as a moonscape. "How do you know that word?"

Lucas gestured at the wellhead, his hands clumsy in their big gloves. "The bugs told me. You don't hear it?"

Marius looked across the yard of space that separated them. "I don't hear anything."

Lucas glanced down at the borehole, his brow furrowed, as if trying to grasp an elusive idea. "They've told me about you. I know what you did. The old man never woke up. When they took him out, his face was pink. Just like the rest. They're all down there, too. Underground—"

When Lucas looked up again, his eyes had acquired a distant, almost dreamy sheen. "It all happened here. The memory doesn't fade. I know what you really are. The bugs pick it up and send it above. If you don't hear it now, you will. And so will everyone else. I can feel it coming."

For a few seconds they stood face to face. Marius found that his fists were clenched, and with an effort, he forced himself to relax. "Go back to camp. Tell Fisher we're starting tomorrow. I'll stay here."

After another wordless moment, Lucas headed for the remaining jeep. Marius kept his eyes fixed on the back of the other man's head, and he did not look away until Lucas had driven off, moving past the vents of steam and the spinal columns of the dead trees that lined the way to the south.

Marius stood there alone for a long time. His heart was still pounding, and with every passing second, the conversation with the convict seemed increasingly unreal, as if he had only imagined it. But he hadn't.

Remembering what Lucas had said, he took a step closer. He hesitated. For the first time, he noticed a sound. It was barely there—a vibration that he felt more than heard—but, for an instant, with the other man's words still ringing in his ears, it seemed like the hum of many tiny wings.

Marius knelt by the metal pipe at the wellhead, his neck stiff from work. He reached out to touch the casing top, then paused again. A borehole, he knew, was nothing more than a column of air going into an empty chamber, and it could resonate in strange ways, picking up seismic

noise from circulation or shifting rock. Sometimes it could sound like a voice. Or something else.

He put his hand on the pipe. At once, he felt it. It was not a voice, or a sound, or anything that could be expressed in words. Instead, it came as an image—as vivid as if he had seen it only a moment earlier—of his grandmother. She wore a veil and a wide straw hat, and her voice echoed strangely in his mind as she looked at the white husk between her fingers. *“We all make mistakes—”*

Marius withdrew his hand. The image disappeared as if a circuit had been broken. But the sound of wings was still there.

He straightened up very slowly, still looking down into the round eye of the borehole. For an instant, he flashed again on those eight bodies in the dark, and he knew that Lucas had been right about one thing. The memory of the past did not go away. He had run from it for most of his life, and now that he had finally come home, he realized that it had been waiting for him here all along.

II.

Elkies pointed at the map of the fire on the screen, which was rendered in shades of orange, blue, and white. Next to the laptop stood the line of six hives that they had retrieved an hour earlier, a few still crusted with green patches of sulfur from their sojourn underground. “We’re looking at four distinct limbs of fire moving in four different directions. Maximum depth of three hundred and ten feet, covering five square miles. At least as far as we know.”

Marius had positioned himself at a spot in the tent where he could easily see the computer while keeping out of the way of the others. They had managed to restrict this meeting to core personnel, but it was still crowded, with representatives from the National Interagency Fire Center in Boise and the Office of Surface Mining standing next to Hal Fisher, his boss, and Maya Narayan, the doctor in charge of the medical and environmental impact team.

As he looked over at Narayan, she gave him a sardonic smile. He managed to smile back, which wasn’t easy. Since coming back from the borehole, he had neither seen nor heard anything unusual, but the impression

of the experience still lingered. On his return, he had checked the fire barracks for Lucas, who was nowhere to be found. And as urgently as he needed to think through this new complication, he also had to deal with more immediate concerns.

The representative from the Office of Surface Mining, which would be footing most of the bill for the operation, peered down at the display. “What concerns me is the schedule. We’ve got a lot of men standing idle. I was informed that we would be starting tomorrow.”

“That’s what I hoped, too.” Elkies tapped the upper right quadrant of the screen. “But this area concerns me. We’ve seen a lot of timeouts. Drones aren’t making it back to the hive. I want to do another round of sorties to fill out the data. Assuming, of course, that there aren’t any objections.”

Even in his troubled state of mind, Marius was faintly amused by this. Elkies might be prickly, but he knew how to stick to his guns. The representative seemed unconvinced. “You said when we got here that you needed four days. If you push on tomorrow, that’s seven and counting—”

Fisher spoke up quietly. “The fire’s been burning for fifty years now. One day more or less won’t make a difference.”

Seeing the representative bristle, Marius had an uncomfortable feeling about where this was going. Hal Fisher was a veteran Texas firefighter who had moved from the forests to the mines, spending years developing the technology being deployed here, and he was a man of seemingly limitless patience, which was a big part of the reason Marius had wanted to work for him in the first place. All the same, after eight years, he knew the older man’s limitations. Fisher had never been particularly good at the political or business side, and while Marius had fought hard to win them this contract, he knew how tenuous the situation really was.

Marius saw that Fisher was waiting for him to speak. He looked around at the others. “Elkies can do the last round of observations in parallel with us. Even if we start right this second, we won’t be fully staged until tomorrow. He can refine his data while we get the infrastructure in place. We’ll turn the key in

the morning." He glanced at Elkie. "That work for you?"

Elkie nodded. "Just give me one more borehole. I can sit on it through the night."

"Good," Marius said, before anyone else could speak. "Just get me the coordinates."

"Already sent." Elkie closed the laptop. "And I'd appreciate it if you could come by once we're running."

"I will," Marius said. After confirming the plan for the rest of the day, he left Elkie's tent at the edge of the camp, which included barracks for the crew, catering trailers, temporary warehouses, and all the equipment needed to kill a fire that covered three thousand underground acres. He welcomed the chance to plunge into action, but there was one issue he still had to address. Passing the barracks, he waved over a member of the convict crew, a friendly hulk named Suarez. "You seen Lucas?"

Suarez shook his enormous head. "Not since this morning. Anything I can do?"

"Tell him I want to see him. He'll know why," Marius continued on, checking his watch as he headed for his own tent. It was already three in the afternoon, and he had a lot to do before sundown.

The first order of business was to send a mobile drilling rig to put down the borehole that Elkie had requested, along with two more to prepare additional injection holes at the points the model had indicated. As he watched them roll away on their clumsy track carriers, he unfolded a map. Over the last six days, the crew had drilled a network of exploratory holes that had to be converted to injection boreholes by tomorrow. These were familiar problems of organization and engineering, and he dug into them with relish, hoping to forget what Lucas had said.

Yet the technical challenges were still formidable. Every fire presented unique problems, and Marius had learned long ago that you had to outwit any enemy you couldn't outfight. A fire close to the surface could be dug out or smothered with fly ash, but here, the usual options were either unworkable or prohibitively expensive. Using water could cause steam explosions, and tankers of nitrogen were slow, costly, and hard to transport on rough roads. Fisher had come up with an ingenious solution, but this would be its

greatest test, and, as Marius got to work, he ignored an old sense that he had pushed them into this contract before they were entirely ready.

He spent the rest of the day going from borehole to borehole, ticking off locations on the map. Because of the scale of the operation, they were obliged to use a combination of methods. Half of the boreholes had been equipped with huge fracturing tanks, cumbersome but effective, with a capacity of twenty thousand gallons. The remaining boreholes had a system that Marius had developed, with a mixing chamber installed right at the injection point. It had never been tested on such a massive scale, and he was determined that it go off without a hitch.

As he made his rounds, he caught a glimpse of Narayan and the environmental impact team, which had been quietly taking soil and air samples for most of the last week. As he watched her at work, he was struck by another thought, and he motioned for her to come over. "Find anything tasty?"

"The usual," Narayan said, stowing a sampling syringe. "Arsenic, selenium, mercury. The surgeon general would love it here."

Marius knew what she meant. A coal fire smoldered like a cigarette, releasing toxins into the environment instead of burning clean. Ever since his experience at the borehole, the question of what they might all be inhaling had disturbed him more than once. "Anything we should be concerned about?"

"We're keeping an eye on the crew. Atmospheric levels are low if you're not standing right over a vent. There shouldn't be issues if your guys are good about wearing their respirators. How are you feeling?"

Marius paused, wondering how much he could tell her. "I've had some headaches."

"Ibuprofen should help. Listen, it isn't the toxins that keep me up at night. Most climate change models don't take coal fires into account. Take this and multiply it by four thousand, and you'll start to see the problem."

Marius did. As a firefighter, he had seen the impact of global warming firsthand. The thousands of coal fires raging in countries from China to Borneo released millions of tons of greenhouse gas, and like most other ecological crises, it was easy to ignore until it

was too late. "Thanks. I'll let you get back to work."

As he moved on, he managed to put the conversation with Lucas out of his mind, and he did not think of it again until dark, when he drove out to the borehole where the last round of sorties was taking place. As he parked and climbed out, ten yards from the wellhead, he sensed the vibration on the air at once. The closer he went, the louder it became, and by the time he arrived at the mouth of the hole, the hairs on the back of his neck were standing on end.

Elkies was seated at a terminal across from Suarez, the crew member he had seen earlier that day, who was positioned by the cable hanging into the ground. The hive was already active. Marius approached, taking care to keep well clear of the borehole. "You hear that?"

"Hear what?" Elkies asked. When Marius didn't respond, the graduate student turned back to the screen. "Everything under control?"

It took Marius a second to understand what he meant. "It's hard for anyone to control a project like this. You put the pieces in place and hope for the best. Even your drones must act in ways that take you by surprise—"

Elkies laughed. "You're talking about the hive mind. That term gets thrown around a lot, but this system doesn't allow for swarm behavior. It's exactly what we're trying to avoid. Ninety percent of the weight and energy budget for an individual drone is devoted to the wings. There's not much left for sensing or control. So we push most of it to the hive."

He indicated the monitor. "The drones can't even communicate in the field. People are always disappointed when I explain that they're just flying sensors. An inertial sensor for navigation, two more for temperature and pressure, and they aren't even particularly accurate. We get good data in the aggregate, but only after they come back. Until then, we're flying blind."

Elkies glanced over at Suarez, who was taking no apparent notice of their conversation. "There's something else I wanted to ask, if it isn't too personal. When you said you were on a convict crew—"

"You want to know what I was in for." Marius smiled. "I ran a policy game."

For the first time in their acquaintance, Elkies regarded him with interest. "A numbers racket?"

"That makes it sound more exciting than it really was. They used to call it the bug. You could say it ran in the family." Marius looked at Suarez, who was still facing away. "I got picked up and was assigned to a fire crew. It was better than running numbers. But both taught me to think in percentages. Like you."

After another short exchange, in which he confirmed that he would check in again once the sortie was done, Marius returned to the jeep. When he closed the door, the vibration around him diminished, but as he looked at the borehole in his rearview mirror, he saw another flash of his grandmother's face. Before, her features had been tired and drawn, but now, she was smiling.

He shut his eyes, waiting for the image to fade. As soon as it was gone, he started the engine and wound his way back to camp. Drawing closer, he saw a line of crew members coming back from the field, and as he passed, he noticed a man watching him until he was out of sight. It was Lucas.

A few hours later, he was lying in his tent, trying to snatch a little sleep before the final push. Most of the senior team had taken rooms at a hotel in the next town, but he had wanted to stay in the fire barracks, near his equipment, and tonight he was starting to regret it.

As he looked up at the ceiling of the tent, he knew that the drones would be going on their last sorties, and although he told himself that nothing could emerge from the hive that had not been coded into it, in the dark that logic seemed harder to accept. If fire had taught him one thing, it was that there were limits to how well you could predict the behavior of any system. It did not seem impossible that a murmur underground could cause unforeseen vibrations above, traveling up the holes in a kind of sympathetic resonance, as one tuning fork could set another in motion. But only, he knew, if they shared a harmonic likeness.

Then he thought of the bees. As he fell asleep at last, the reverberations he imagined

from below merged with the memory of his grandmother, whose face he still saw whenever he closed his eyes.

His grandparents had come over as displaced persons after the war, settling in a town outside New Philadelphia with the largest Lithuanian population in the country. In those days, immigrants had taken on the mining jobs that others didn't want, like an opportunistic species looking for a niche to fill. His grandmother had endured for longer than anyone, holding on after black lung had taken her husband, just as it would one day claim Marius's own father.

But that had come much later. His father had been a big man, quick with his fists and belt, and once he was old enough to move around on his own, Marius began spending more time with his grandmother—arriving at her house after school and staying until well after dark. She was a stern but lovely woman, still intimidating in her seventies, and even his father kept his distance.

Algis, his uncle, also lived there. Unlike his brother, he was cheerfully irresponsible, and for years he had worked as a runner for the local numbers game, carrying money and betting slips for Garastas, the neighborhood gangster. Garastas was a supremely ugly man of sixty who sometimes came by the house, treating everyone with coarse familiarity, and Marius was wary of him until his grandmother told him about *biciulyste*. In the old country, the bees kept by one household would swarm and take up residence on another man's land, binding them with a kinship that could not be broken. Garastas, for all his posturing, came from a family that was united to theirs, so there was no reason to fear him. Or so she claimed.

Marius trusted his grandmother's word on all matters, but particularly here. She kept a pair of hives in the southeast corner of her garden, propped up on cinderblocks near the hemlock trees that had been planted as a windbreak. Out of respect for tradition, she did not sell the honey, but gave it freely to friends and family, and she tended the bees ungloved, wearing only a veil for protection. They would not sting, she said, if you treated them with respect.

He listened attentively, first as a way of becoming close to her, and later because the

bees fascinated him in their own right. According to his grandmother, you could inspect the hives only a few times each season. Whenever you lifted off the cover, you disturbed their work, so you had to use deduction and observation instead. Marius never forgot this lesson, just as he always remembered the exotic words she used. *Propolis*. *Supersedure*. *Stonebrood*.

There was also a darker strain of tradition that he absorbed without fully distinguishing it from the rest. You told the bees about events in your family, until the hive became a repository of your secrets, and when you discovered a dead bee, you buried it just as you would another human being. In Lithuanian, distinct words were used to describe the deaths of different types of animals, but the words for a dead bee and a dead man were the same.

Marius thought of this on the day he learned that his uncle had died, in the summer he turned fifteen. Algis had been missing for close to a week before his body was found in the Schuylkill River, weighted down and shot twice in the head. After hearing the news, he ran to his grandmother's house, only to find her preparing for the inspection she had planned for later that day. She took in his tearful face and adjusted her veil. "You can tell it to the bees."

He followed her outside to the rear porch, where she prepared the smoker, filling it with crumpled paper and lighting it with a match. As she added a handful of kindling, followed by coils of hemp twine, her expression remained impassive. "Algis was a fool. He was my son, but even I can say what he was. He did not understand that you cannot control certain men. You must be ready for trouble before it breaks out. But he was always too careless."

She squeezed the bellows, releasing a wreath of white smoke. Marius ran behind her as she headed for the garden. "But the *biciulyste*?"

His grandmother blew smoke into the entrance of the first hive. "It is just a word."

As she lifted off the top, he caught a glimpse of the fear she had always kept locked inside. He watched, sick at heart, as she pried up the inner cover with the end of her hive tool. "Are you afraid?"

Pulling out the first frame, she studied it. "It is not my concern. This was between Algis and Garastas. You're an intelligent boy. If you knew what was best, you would not ask questions. Look here."

She showed him that only a few stray bees were crawling across the comb cells, many of which had gone black. When she shook the frame, crusts of mummified larvae fell to the ground. She picked up the nearest husk, turning its chalky remains over in her fingers. "We all make mistakes. No matter how careful we are. And we have to learn to live with it."

Marius looked at the larva, then at the smoker, and last of all at his grandmother's face. He had thought he was safe here, but none of them were. And it wasn't until much later that he had begun to see a way out.

That had all been twenty years ago. Now, opening his eyes, he found himself back on his cot in the barracks. He rose, his neck still stiff, and saw that it was time to meet Elkie.

Outside, the fire camp was quiet. Marius was making his way to the jeep when he saw a man standing by the line of transport vehicles, his head tilted to one side, as if listening to a whisper from the ground.

At the sound of his steps, Lucas turned. He was smiling. "I've been waiting for you."

Without quite knowing what he was doing, Marius came forward and pushed Lucas roughly against one of the trucks. "You can't threaten me. And I'm not frightened of you. Tell me what you want."

Lucas shook his head. "Nothing. I just tell you what I hear. It has nothing to do with me. Only you. I know this now."

Marius released him and stood back, his head pounding. "Who else have you told?"

"No one," Lucas said. "There's no need. Everyone will know it soon. The bugs hear it all. You can't drown it out, no matter how you try. You would know this if you had ears. They're still there—"

Marius thought randomly of what Elkie had said. Some fraction of the drones had timed out, never returning, lying forever in the tunnels as their power ran down. "And what are they telling you now?"

Lucas turned away. "We will meet again. At the tree of life. The last one standing."

"Here?" Marius gestured at the ravaged landscape around them. "All the trees died."

"There's one left. You'll see it when the time comes. They can tell you where it is, if you listen to them." Lucas seemed about to say something more, but instead, he detached himself and walked away into the night. A moment later, he had disappeared into the darkness.

Marius stared after him. Faintly, the sound of wings rose again in his mind, less like a real vibration than a memory, although he did not know if it was from the drones or his grandmother's hive. Then he went to find Elkie.

Work resumed early the next day. At eight in the morning, his head aching, Marius found himself standing beside Fisher at a borehole near the center of the impact zone. Fisher grinned. "You ready?"

Marius managed to nod. He had not heard the wings again. "Let's turn the key."

Fisher signaled to the crew member by the borehole, who knelt at the wellhead and switched on the mixing chamber. Marius heard a hiss as the pipes engaged: one for foam concentrate, which was based on ordinary dishwashing detergent; one for water, which was pumped from the creek; and one for nitrogen gas, extracted by a membrane system from the atmosphere.

Once it was running smoothly, he opened a valve on the wellhead, sending an arc of foam spurting into the air. As the crew applauded, he kept his eye on the foam, which was good and dry, like shaving cream. He closed the valve and gave a thumbs up to Fisher. "Let's check the rest."

They headed off on their inspection tour. At the moment, there were twenty injection boreholes, along with relief holes to manage the buildup of steam. Five thousand gallons would flow into each wellhead every minute, coming to seven hundred million before they were done.

As they moved from one borehole to another, Marius tried to picture the scene in the mines. When the foam reached the underground chambers, it would saturate the interior, penetrating every crevice until it roofed out at the ceiling. As the bubbles met the heat, they would burst, the pressure from the nitrogen pushing out oxygen and

the water on the coal making carbon dioxide, suffocating the fire where the foam couldn't reach. Nothing down there, he told himself, could survive.

Around dusk, he encountered Lucas again. The convict was working with a team at a borehole near the camp, and as Marius approached, the other man regarded him evenly. Marius moved on without speaking, but all the while, his mind was considering the many ways a man could be killed on a job like this. Between the drilling, the heavy equipment, and the uncertainties of any industrial operation, it would not be hard to arrange for an accident. Not if he was careful—

Marius suddenly realized what he was thinking. He halted, feeling that he had been confronted by a side of his personality he had tried to deny for years, and he had almost succeeded in pushing it away again when he saw foam pouring out of a relief hole in the ground.

It was not unusual to see foam emerging, but even at a glance, he could tell that it was coming out far too fast. It was soupy and thin, with too much water, which could lead to dangerous levels of pressure as the vapor underground built up faster than they could put out the fire.

Even as this thought flew into his mind, the foam gave way to a funnel of steam. Beneath his feet, the ground shuddered, and as he ran toward the wellhead, the earth itself seemed to bulge around the pipe.

A member of the convict crew stood by the mixing chamber, staring into space. Marius rushed to shut the valves, then seized the man by the shoulders and spun him around. "What the hell were you thinking?"

The man stared back. It was Suarez, the convict who had been working with Elkies the night before. Looking into his eyes, Marius saw an empty, distant expression that he knew all too well, and before he could stop, he heard himself speak. "You've heard it, too?"

Suarez nodded, evidently dazed. Marius saw the other crew members coming closer when he felt something settle on the back of his neck. It was delicate, almost gentle, like the touch of an insect.

He reached back and plucked the object away, feeling it vibrate between his fingers. It was a drone.

Marius felt his headache return, along with the sound of wings, now louder than ever. Turning, he saw more drones in the air around him, floating like motes of dust in the dying light.

At his side, Fisher swatted the drones away. "What's happening? Where's Elkies?"

Marius was about to reply when his eyes fell on Elkies's tent, which stood at the edge of the camp, recognizable by the antenna on its roof. He found himself moving forward, passing more of the drones, and as he did, he saw that they were all heading in the same direction.

He reached the tent and yanked open the flap. Inside, Elkies was lying on the ground, one of the hives overturned beside him. He was convulsing, his face rigid and pale, the corners of his mouth flecked with white froth. Throughout the tent, like a cloud of gnats, the drones were beating their tiny wings against the air, trying in vain to find their way home.

III.

Narayan shone a penlight into Elkies's eyes, raising the lids one at a time. The three of them sat on the tent floor, with Marius supporting the graduate student by his shoulders, feeling the tremors racking his slender frame. Through the door, he could see the rest of the team standing outside, talking quietly but nervously. Narayan switched off the light. "Let's get him to the medical tent."

As they rose, Marius saw that the doctor's expression had darkened. "What is it?"

"I don't know," Narayan said. "But I need to see everyone else. You can send them to me one at a time."

Marius helped her haul Elkies, who was semiconscious, to his feet, handing him off to the others. Instead of following, he stayed where he was, waiting as the voices began to fade.

The drones in the tent had all clustered above the tabletop, and he could hear countless others beating softly against the tent's exterior. Kneeling, he picked up the hive from the floor and set it back on the table, at the spot by the laptop from where it had fallen. At once, drones began to enter through the openings at its base, returning for their scheduled charging cycle.

Marius went to the flap of the door and pulled it back. Then he sat down across from the desk and watched as the drones made their way into the hive, arriving one by one and burrowing inside.

He remained there for a long time, turning things over in his head, and he did not stir again until a voice came from behind him. Looking up, he saw that Narayan had entered, and he realized that nearly an hour had passed.

Narayan knelt beside him. "We need to talk. You said you'd been having headaches. Where are they?"

Marius pointed toward the center of his forehead. "Right here. Between my eyes."

"What about other symptoms?" Narayan asked. "Any muscle stiffness or rigidity?"

"My neck has been stiff for days. I thought I was just out of shape." He began to understand. "Is it the toxins?"

Narayan shook her head. "I don't think so. How's your mental state? Have you experienced visual or auditory hallucinations?"

The whisper of the wings still persisted in his head. "Tell me what's going on."

Narayan only straightened up and indicated the hive on the table. "There are six hives altogether, right? I need to find them all."

Marius rose from the chair. Going to the corner of the tent, he undid the clasps of the cases on the floor. Inside each one, on a bed of sculpted foam, lay a hive. "Five here. Plus one over there."

"We need to seal off the tent." Narayan shut the lids, then put on gloves and picked up the remaining hive, holding it at arm's length until it was safely inside its case. "As far as I can tell, what happened to Elkie's only affected workers who were in contact with hives or drones. We need to get you to a hospital. I've already called ahead to the medical center in Potsville."

They left the tent together. Narayan paused as they emerged into the fire camp. "I'm sorry, Marius. We should have caught it earlier. But the environmental factors confused things—"

Outside, night had fallen. As Narayan led him away from the tent, Marius noticed that a group of workers had been pulled aside near a transport van, and they did not look

happy. Glancing at their faces, he saw Suarez, but another man was missing. "Where's Vincent Lucas?"

A quick check of the camp confirmed that Lucas was nowhere to be found. Marius remained where he was, thinking of what the convict had said. *We will meet again. At the tree of life. The last one standing—*

It took him only a fraction of a second to make his decision. When Narayan returned to usher the group into the van, Marius drew her away. "I need to see Fisher. If I'm gone, I want to make sure he has what he needs."

Narayan looked as if she wanted to object, but something in his eyes seemed to convince her. "Five minutes."

"I understand." Marius moved away from the van. As soon as Narayan was looking in the other direction, he switched course, heading away from the center of camp. No one paid him any attention in the confusion.

His jeep was where he had parked it, behind his own tent. He climbed in and started it up, keeping the lights off. Checking the rearview mirror to make sure nobody was watching, he put the vehicle in drive and eased forward on the uneven ground, going at a crawl, until he was certain he had not been noticed. Then he turned toward the ruins of Perry Township.

Marius knew the map of the area by heart, but he still took it slowly, his tires crunching over the dead branches and vegetation. He managed to find the old state road without using his lights. In places, the asphalt had cracked as the ground beneath it subsided, but it was comparatively easy going, and before long, he saw that he was nearing the abandoned town.

When he switched his headlights on, his surroundings came into focus. He was entering a grid of deserted streets—the sidewalks still lined with stop signs and fire hydrants, but the buildings themselves long since demolished. At intervals, smokestacks the height of a man had been set into the ground, releasing columns of steam, like cigarettes sprouting from an ashtray.

All of the houses were gone. As he drove toward the center of town, he passed drive-ways that led nowhere, terminating in weeds

after twelve feet. In places where the earth had settled and cracked open, the grass was strikingly green. An absolute silence covered the ruins, and he heard nothing except his own engine and the rising murmur of wings in his head.

Feeling a dip as the road under his tires sloped down, he saw that long stretches of the street had buckled, sagging in the center like a worn mattress. He slowed to five miles an hour, then pulled over and got out. Before he left the car, he took out a pair of respirators, fastening one over his face.

It was not far to the center of town. He had been here earlier that day, checking a set of injection boreholes that had been drilled near where a handful of the original wood-frame houses still stood. The surviving homes had been boarded up—the plywood covered with danger notices and graffiti—and empty cigarette packs and bottles of booze littered the sidewalk.

In the distance, he saw a dome silhouetted against the sky. As he neared it, he found himself thinking of another night, from twenty years ago, and although he had been pushing the memory away, he finally let it in. To keep his thoughts from flying apart, he had to remember everything.

Two weeks after his uncle had died, Marius had slipped out of the house after his parents had gone to bed. He had moved on foot through the familiar streets of his hometown, keeping as much as he could to the shadows, carrying nothing but a metal pail with his tools.

After covering a mile in the dark, he arrived at the house he had come to visit. Lowering his pail over the fence at the rear, he vaulted across, landing noiselessly in the back yard. Earlier, he had determined that the window leading into the kitchen could easily be forced, and now he pried it open.

Except for the hum of the refrigerator, the kitchen was quiet. Leaving the lights off, he closed the window and crept through the dining room toward the stairs. In the glow of the streetlamps outside, he saw that the house was small and sad, and for a moment, he nearly reconsidered his plans. Ultimately, however, he moved on, ascending the steps to the second floor.

In the bedroom, Marius checked that all the windows were closed and then headed for the closet. He sat among the coats, his knees to either side of the pail, and drew the door shut behind him. His greatest fear had been that he would somehow nod off, but now the possibility of sleep seemed very far away.

He waited for perhaps two hours before hearing the front door unlock and open downstairs. Straining to listen, he made out voices on the porch, a low chuckle, and the sound of the door closing again. He had made a careful study of the old man's habits, and he knew that he spent most nights out drinking with his cronies, rarely returning before one or two in the morning.

After another minute, he heard the risers creak. Marius was afraid that the beating of his heart would give him away, but he forced himself to remain still as a light appeared under the closet door. There was the sound of urination, followed by the flush of the toilet. Then the footsteps returned to the bedroom, where they paused directly in front of his hiding place.

Marius tensed himself, his heart knocking, bracing for the closet door to come open. In the end, the steps turned aside again, and the light went off. The box springs sang as a heavy shape lowered itself into the bed. Almost immediately, he heard the sound of snoring.

He did not move for a quarter of an hour, and when he began to ease open the closet door, it was another five minutes before the opening was wide enough to get through. Then he was standing in the center of the bedroom, looking down at the slumbering form of Garastas.

The gangster was passed out on his back. Marius stared at the rising and falling chest for a long time, telling himself that it was still possible to leave. Finally, however, he remembered his uncle, whose body had been so ruined by the river that the casket at the funeral had been closed.

Pulling on heavy gloves, he set down the pail in the farthest corner of the room, moving slowly to keep the boards from squeaking. Earlier that day, he had punched a series of holes around the pail's base. Taking the bottle of lighter fluid from his pocket, he squirted the liquid into the pail, his hands

shaking, and when it had soaked into the briquettes, he lit a match and tossed it inside.

Behind him, the old man stirred in bed. Marius looked over sharply, his pulse racing, and saw Garastas shift position. A second later, the snoring resumed, louder than it had been before.

Marius turned back to the pail, where the briquettes were glowing. After what seemed like forever, he saw that the charcoal was covered in gray ash. He stirred it with the tip of the long knife he had carried in his other pocket, and once it was ready, he lifted the pail by the handle and set it in the middle of the room.

He gathered up his tools and left without looking back, pausing only to make sure that the door was tightly shut behind him. Moving downstairs, he went back the way he came, raising the kitchen window and hoisting himself onto the sill. A second later, he was in the yard and over the fence.

When he raised his head on the other side, he found himself looking at a boy standing in the shared alley to the rear of the houses. The boy was maybe twelve years old, too young to be out this late, his dark eyes wide beneath a high, pale forehead. They were about ten feet apart, and for a moment, they simply looked at each other. Before either of them could speak or move, the boy turned and ran, vanishing almost at once into the shadows.

Marius remained rooted to the spot. At last, he stood and went the other way. A block from his house, he stopped at a patch of dirt in an abandoned lot, where he buried his gloves and knife with a trowel he had left there earlier. As he covered the hole with earth, he tried to tell himself that the boy had only seen him for a second, and in any event, it was out of his hands.

The following day, he went to see his grandmother. She met him at the door, and he knew at once that she had heard the news. Garastas had been found by his men at home, dead from carbon monoxide inhalation. Neighbors who had seen the body removed said that its face was flushed and pink.

Standing on the porch, Marius drew himself up to his full height. "We're safe."

His grandmother only looked at him. There was something gathering in her eyes that frightened him, although he would have found it hard to explain why. Then she knelt and opened her arms.

Marius buried herself in her embrace. Even then, however, he had been troubled by what he had seen a second before, and it had taken him a long time to understand what it meant. For an instant too short to be processed, his grandmother had smiled, but it had not been with relief. Instead, it had been with a kind of dark satisfaction. And he had seen it before on the face of only one other man.

More than twenty years later, as he neared the heart of what remained of Perry Township, Marius thought back to that smile. He understood now that it had been the moment his life had truly changed, and all that had happened since had only served to bring him to this very place.

He stood before the church. Looking up, he saw that its onion dome was wreathed in the smoke drifting up from the vents in the ground, which was covered in warm fog. The steps were lightly dusted in ash, and when he neared the doors, which were open, he saw a line of fresh footprints.

The interior was in darkness. Marius groped his way down the aisle, waiting for his eyes to adjust, past rows of pews covered with flakes of plaster like leaves. As he moved toward the altar, his feet crunching in the debris, he felt as if the last twenty years had fallen away. The murmur of the drones was rising.

He halted in the apse, before what remained of the stained glass window. Incredibly, it was nearly intact, and in the moonlight, he could make out the shape of a cross superimposed on the image of the world tree, its roots going down to the underworld, its branches spreading to welcome birds and other flying creatures. Lithuania had been the last country in Europe to accept the church, and its pagan symbols had survived wherever they could.

At the base of the window stood a row of saints. Marius recognized Saint Casimir, his three hands each holding a lily, and Saint Christopher, who bore the savior on his

back, and he was trying to remember the others when one of the shadowy figures unexpectedly moved.

Lucas was seated beneath the window, his knees drawn up to his chest. He was shaking. "I've been waiting for you. They must have told you where to find me. Can you hear them?"

Marius removed his respirator. He spoke carefully, knowing that it was the only way to cut through the delirium that threatened to claim them both. "Yes. But that wasn't how you knew who I was. You say your name is Vincent Lucas. What was it before you changed it?"

Lucas glanced aside, as if recalling a person long forgotten. "Vincas Lukminas."

Marius felt a tremor pass through him. "You saw me that night. And you remembered my face all this time?"

"I used to see you around town. You probably don't remember me. When I saw you again here, I wasn't sure it was you." Lucas rose slowly to his feet. "I didn't know until I heard it underground. It was so quiet there in the field. And I started to listen to what they were saying."

"It was nothing you didn't already know. Why didn't you give me up then?"

Lucas looked at him as if he were a fool. "Because of your grandmother. We all knew who she was. She was always the one we feared most. Garastas was the only man who could stand up to her. When he died—"

"I know," Marius managed to force out the words. "I didn't understand at first. By the time I did, I was already a part of that world. I did what she wanted without knowing it. When people came to pay homage to her, after Garastas was dead, I thought to myself that this was true power. And I wanted to go deeper. But after prison, I started to see what she really was. A queen pushing out a pretender. So I got as far away as I could. I thought it would be safe by now. But I was wrong."

The words hung in the air between them. Lucas came forward until they were only a few feet apart. "Are you going to kill me?"

"No," Marius said. "It's *biciulyste*. The drones started with you and settled on me."

He extended the second respirator. After a second, Lucas took it. They left the church,

passing silently into the wall of smoke, and as they emerged, Marius found his mind returning repeatedly to the same thought, guided there by the sound of wings in his head. He had killed a man, twenty years ago, and the guilt still lingered. Tonight, he had spared another. Yet no matter how many lives he saved, here or anywhere else, it would never be nearly enough.

"Thanks for making time for this," Narayan said. "I had a feeling you were avoiding me, but I wasn't sure why."

"It's been busy. And I had to work out a few things first." Marius looked across the street at the row of houses. "My flight leaves in two hours. I was making one last stop when you called."

Narayan followed his eyes. "I didn't mean to interrupt. This is where you grew up?"

"Something like that," Marius said. "It's a place from the past. I wanted to see if there was anything here. But there isn't."

Marius studied the house, which had been sold shortly after his grandmother died. He had waited until the last possible moment to come. To one side of the brick porch, he saw that the hemlocks were still standing in the garden. He had thought about ringing the bell, but instead he had walked along the sidewalk, searching for any trace of resonance but finding nothing. "You can walk me to my car."

As Narayan accompanied him up the block, he felt her scrutiny on his face. "How are you feeling?"

"I'm fine," Marius said quickly. "I still hear the sounds sometimes. But that's all."

He wasn't sure if she believed him. In the end, he had spent two weeks in the hospital, receiving a cocktail of antimicrobial drugs, along with twelve other members of the team. He had persuaded them to let him return for the last phase of the project, long enough to confirm that the fire was out. After his recovery, Elkie had wanted to do one last set of sorties to make sure, but he had been quickly overruled. "You must have wanted to see me for a reason."

"I owe you an explanation," Narayan said. "And an apology. We're finally starting to get a sense of what happened."

He indicated that she should go on. Narayan turned away, looking at the fall foliage that had been kindled on the trees lining the street. "You'd think that nothing could live underground in those conditions, but that isn't entirely true. We knew, for instance, that there were thermophilic bacteria in the soil near the vents. They reduce carbon in the coal and leave sulfur behind. That's why we saw sulfur encrusted on the hives when they came up."

Marius had gathered much of this already. "But that wasn't what caused all this."

"No. But it was the basis for an ecosystem. We've found all kinds of things by the vents. Microarthropods, like springtails, and mites. Opportunistic organisms taking advantage of reduced competition. You find interesting things in extreme environments. Pharmaceutical companies sometimes look for leads at coal fires. They won't have a chance to do it here."

He sensed her circling around the real point. "You still haven't given me a name."

"Our best guess is that it was amoebic meningitis," Narayan said. "We hadn't heard of this form of it before, but cases in the literature are rare anyway. You see similar organisms living in thermal discharges at power plants. The human body is at the low end of their temperature range. We didn't figure it out because everyone was feeling the effects of the environment. It was only when it had progressed far enough to cause hallucinations or convulsions that we knew."

Marius overheard a note of reproach in her voice. "It wasn't exactly your fault."

"We could have been more careful. The respirators were fine when it came to the fumes, but cysts can stick to exposed skin and be inhaled or absorbed through the eyes on their way to the brain. We're still not sure about the mechanism. Either the drones picked it up in the chambers or it ended up on the hive itself. I understand the hives got pretty warm underground—"

Marius nodded. "The drones used inductive chargers. They give off a lot of heat."

"And they were down there for hours at a time," Narayan concluded. "It was a perfect recipe for contamination. We're not sure what the lasting effects will be. But it only affected those who handled the drones or the hives."

A word from his own childhood unexpectedly floated into his mind. "Stonebrood."

Narayan seemed to think that he was suffering another hallucination. "Excuse me?"

"Stonebrood. That's what it reminded me of. It's a disease of bees. The larvae become chalky and mummified. If you're not careful, it can be caught by the beekeeper. And we all make mistakes." Marius halted by his car. "I wanted to ask about Lucas. He never returned to the project."

"I saw him a few days ago. A routine checkup. He'll be fine. But he says he doesn't remember anything." Narayan looked at him as he pulled out his keys. "So where are you going now?"

Marius unlocked the car. "Back to Texas. Fisher and I have work to do at home."

When he extended his hand, Narayan only folded her arms. "How many coal fires are still burning in Pennsylvania?"

"Forty," Marius said. "Under the circumstances, I doubt we'll get a shot at them. At least not until someone else dies. It took eight people here. Hopefully, next time, it'll be fewer."

Narayan shook her head. There was something like sadness in her eyes. "They'll ignore it until they don't have a choice. As if it will go away on its own. But I guess that's human nature."

"I suppose it is," Marius said. He opened the door and slid inside, watching as Narayan headed for her own car. Then he started the engine and pulled away without looking back. ■

Alien Adventures: Rising to the Challenge

Edward M. Lerner

Among the simplest explanations for the Fermi Paradox (right after “we *are* alone in the Universe”) would be that communicating or traveling between stars is simply too hard.¹ Does that make all science fiction of an interstellar nature merely a willing-suspension-of-disbelief pact between storyteller and audience?

Are we all starship trope-ers?

Perhaps. But I recently spent a long week-end with a couple hundred people, from twelve countries, determined to prove there *is* a way to the stars—and who are working to make that happen within a century.

100 Year Starship

Back in 2011, NASA and DARPA² cospon-

sored the first 100 Year Starship conference. The purpose of that gathering was “to begin studying what it would take—organizationally, technically, sociologically, and ethically—to send humans to another star, a challenge of such magnitude that the study alone could take a hundred years.”³

How was such an epic study to be performed? By enlisting, initially with DARPA seed funds, an organization dedicated to that long-term project. That initial conference and its grant competition led to several forward-looking endeavors and follow-on symposia.

100 Year Starship (100YSS) is the organization that came about directly from the grant competition, and whose most recent (September 18–21, 2014) annual symposium I had

¹ The paradox: if, as some suppose, the vast Universe *must* be home to other intelligent beings, why don’t we have any evidence of them? Why haven’t we detected their radio transmissions, or seen their starships, or found some trace of their past stopovers?

For (much) more about the absence of such evidence and many possible explanations, see my article “Alien AWOLs: The Great Silence,” in the October 2014 issue.

² That’s the Defense Advanced Research Projects Agency, best known—outside the defense community, anyway—for the R&D that gave rise to the Internet. (The defense interest, back during the Cold War, was in creating a highly distributed, hence highly reconfigurable and fault tolerant, communication network to supplement the very hierarchical, very vulnerable public switched telephone network.)

³ “Offering Funds, U.S. Agency Dreams of Sending Humans to Stars,” Dennis Overbye, *The New York Times*, August 17, 2011, <http://www.nytimes.com/2011/08/18/science/space/18starship.html>.

One of the presentations at that conference became the basis of “Homesteading to the Stars: Colony vs. Crew,” Arlan Andrews, in the December 2013 issue of *Analog*.

the good fortune to attend. In this article, I'll draw upon that symposium's technical-track and plenary sessions—and from cocktail-party conversations and chance hallway encounters—to give a big-picture look at the challenges of interstellar travel. I won't cite any symposium papers—as I write, the proceedings remain unpublished. I've referenced other supporting material where available.

(For a bit of background on the 100YSS organization itself, see the sidebar *Physician. Former astronaut. Woman with a mission.* on pages 27 and 29.)

As usual in this science-behind-the-fiction article series, expect the occasional SFnal citation. Many among the symposium presenters did the same.⁴

Why interstellar travel is so hard

The most obvious difficulty of interstellar travel is that other stars are so remote. Proxima Centauri, our Sun's nearest neighbor, lies 4.22 light-years—that's just less than 25 *trillion* miles—away. Humanity's farthest ranging spacecraft, the *Voyager 1* probe—after 37 years of flight, and just barely entered into interstellar space—remains within one light-day of the Sun. That's a fraction of 1% of the Sol/Proxima Centauri distance.⁵

The *Voyager* probes were sent on their long journeys by chemically propelled rockets (supplemented by repeated gravity assists via precisely planned planetary flybys). To cross

interstellar distances will require both new, far more powerful, means of propulsion and the taming of vast energies. 100YSS certainly includes those topics among its interests. I sat in on, for example, an update from NASA propulsion technologist (and SF author) Les Johnson on the state of solar sailing. I also saw a presentation by physicist Jeff Lee on exploiting the Hawking radiation of a quantum-scale black hole.⁶

Cool stuff, that, to be sure, but *Analog* often offers fact articles about propulsion and energy.⁷ A better use of our limited space is to focus on other challenges to be faced (some of them anyway—to have attended every technical presentation at the symposium required being in several places at once) on our way to becoming an interstellar civilization.

Staying in the loop

Humanity evolved in a particular environment. We rely upon Earth's air, water, gravity, and narrow range of temperatures. The planet's atmosphere and magnetic field protect us from solar ultraviolet radiation, solar wind, and cosmic rays. We share our world with a rich and varied web of life, upon which we depend for food and the very oxygen we breathe.

All of which must somehow be provided (or substituted for) throughout any spaceflight. Unless the Universe's speed limit turns out to be faster than light, that artificial environment must be sustained, at the least, for years.⁸ Quite

⁴ Science Fiction Stories Night, a discussion among SF authors, was one of the main events. I was one of the panelists, and (full disclosure) the symposium organizers reimbursed many of my costs to participate.

⁵ Controversy rages as to when (or whether) the *Voyager* probes crossed the ill-defined border between the Solar System and interstellar space. For more on that debate and the latest statistics on the two probes, see the JPL project home page, <http://voyager.jpl.nasa.gov/>.

⁶ I grant you, a quantum-scale black hole sounds small. It *is* small: far tinier than an atom, or even an atomic nucleus. But small needn't mean insignificant: a quantum black hole masses about three-quarter million tons, and spews out one hundred petawatts per second. It will pump out energy for years before evaporating.

And a funny thing about black holes: the more one evaporates, the faster it emits energy. (Until the object has lost too much energy (which—recall your Special Relativity—is a form of mass) to remain a black hole. You *really* don't want to be around when that transition happens.)

For reference, the U.S. Energy Information Agency reports worldwide energy-production capacity in 2011 (the latest year for which data are available) at about 5.3 petawatts.

Humanity is—for now, perhaps for the best—unable to fabricate black holes.

⁷ Many of John G. Cramer's "Alternate View" columns here in *Analog* have addressed one or another speculative interstellar drive (links to articles are at http://www.npl.washington.edu/AV/av_index_sub.html#8).

⁸ See my article "Faster Than a Speeding Photon: The Why, Where, and (Perhaps the) How of Faster-Than-Light Technology," January/February 2012 issue. Of course, even if an FTL technology *does* prove possible (and practical), an FTL journey may still be of significant duration.

possibly, the environment must be sustained for generations. As the Biosphere Two experiments and the frequent resupply missions to the International Space Station both attest, we're a long way from knowing how to sustain a closed-loop ecosphere.

In a closed-loop, bounded environment, every type of resource is in limited supply. *Everything* must be reused. Tools, repair parts, furniture, and many other items will be produced as needed, then broken down and recycled, rather than tie up scarce space and materials. Whatever the daily shipboard processes turn out to be—perhaps to include agricultural, industrial, machine-shop fabrication, and 3-D printing activities—byproducts and waste, if only in trace amounts, will insinuate their way into the closed-loop environment.

Will the gradual accumulation of such contaminants degrade the ecosphere? Be toxic to crops or crew? Prove carcinogenic or mutagenic? Trigger addictive or allergic reactions?

Staying alive

A major theme of the symposium, with many recurring subtopics, was keeping humans healthy while off Earth. In a summary as abbreviated as this, I can't always attribute a particular concept to a single life-sciences speaker. To everyone thus synopsized to anonymity, I apologize.

Let's consider some aspects of the life-support problem.

Among the health consequences of microgravity conditions is the gradual loss of bone mass. At least one extrapolation from astronaut experience to the duration of a round-trip Mars expedition suggests bone-mass loss

similar in extent to two years of menopause. Will the deterioration continue as long as crew are in micro-gee, or will effects plateau after a period of acclimation? That remains unknown. Absent near-light-speed travel (so that, courtesy of relativistic time dilation, from the crew's perspective the journey seems short) or FTL technology, bone-mass loss on an interstellar flight could be severe.⁹

Bone mass doesn't just disappear. Minerals, mostly importantly calcium, lost from bone are processed through the kidneys. That's why astronauts are prone to develop kidney stones.

Nor is bone-mass loss the only health consequence of microgravity. The shifting of bodily fluids under these conditions increases intraocular pressure and can lead to degeneration of the optic nerve. That is, prolonged micro-gee can impair eyesight.

That's microgravity. What about unfamiliar levels of gravity? Will long periods spent on Mars or Europa, on worlds in other solar systems, or in the gravity-simulating context of a large, rotating, *2001: A Space Odyssey*-like spacecraft also impact health? Likewise, to be determined.

Does the presence or strength of gravity play a role in the development of fetuses? Gestating in microgravity, at the least, may be problematical.¹⁰

Then there's radiation. Cancer is an obvious risk, but not the only one. Over the course of evolution, earthly life has incorporated into its DNA many long dormant retroviruses. If radiation should activate or mutate such retroviruses, we'll have no experience with, or immunity to, them. We already know that the spacecraft environment isn't friendly to our immune system.¹¹

⁹ Bone-mass loss in microgravity conditions (and candidate preventive measures) is a complex topic, with outcomes influenced by the extent of exercise, type of exercise equipment, and drug treatment. At least one exercise-and-drug regimen might limit long-term bone-mass loss to 15%. See Reference 5 on the last page for a fuller discussion.

Of course even the longest experiences to date with microgravity are far briefer than any (non-FTL) interstellar transit.

¹⁰ "Making Babies in Space May Be Harder Than It Sounds," Brandon Keim, August 25, 2009, <http://www.wired.com/2009/08/spacebabies/>.

¹¹ "According to Crucian, the immune system is likely being altered by many factors associated with the overall spaceflight environment. 'Things like radiation, microbes, stress, microgravity, altered sleep cycles and isolation could all have an effect on crew member immune systems,' said Crucian. 'If this situation persisted for longer deep space missions, it could possibly increase risk of infection, hypersensitivity, or autoimmune issues for exploration astronauts.'"

See <http://www.nasa.gov/content/study-reveals-immune-system-is-dazed-and-confused-during-spaceflight/>.

Nor will only human genes be at risk. Microbial hitchhikers (our “microbiome”) outnumber human cells by ten to one.¹² These cohabiting cells will also be exposed to radiation and other unnatural aspects of the spacecraft environment. New diseases may emerge. Critical symbiotes may die off. Familiar diseases may become more potent and resistant to the pharmaceutical stocks with which the voyage began.¹³

Light-years from the rest of humanity, at risk of these difficult-to-pre-characterize hazards, the journey is certain to be stressful—and prolonged stress is yet another health risk. Among its effects, stress can negatively impact the immune system.

Let anyone suppose this was a complete enumeration of interstellar travel’s medical risks, some humility is in order. Not long ago medical science didn’t know that our health required trace nutrients. Geophysicists had no inkling that an invisible magnetic shield protects us from a deadly sleet of equally invisible solar and cosmic radiation.

Life aboard a starship may reveal things we don’t yet know.

You are getting sleepy. . . .

Several of the life-support challenges aboard a spaceship seem more tractable if passengers sleep their way to the stars. Passengers in deep sleep would use less food, water, and oxygen. They would generate less waste to be recycled (and less waste that, eluding recycling, degrades the shipboard environment). They would avoid the stress of years-long travel, and could be more readily sheltered from radiation.

Not surprisingly, crossing deep space in “cold sleep” is an SF staple (as in, for example, the *Alien* movie franchise). But is cold sleep possible?

Marcel Dirkes, M. D., in his presentation on suspended animation, noted that state-of-the-art hypothermic treatment lowers human body temperature for days to the range of 86–93°F. State-of-the-art cardiovascular support may lower body temperature for hours to the range of 68–78°F. Set aside that those intervals are far too brief for an interstellar journey; at those temperatures, the body is still actively metabolizing—read: consuming food and oxygen.¹⁴

In contrast, hibernating mammals (the details varying by species) sustain temperatures of as low as 27 °F for months.

Dirkes cited experiments showing that hypoxia can trigger hibernation in mammal species that don’t normally hibernate. Ordinary lab mice don’t hibernate—until sealed in a chamber whose oxygen is lowered to 5% (versus the atmospheric norm of 21%). Thermal imaging of these mice shows their bodies uniformly reduced to ambient temperature. That is, the metabolism has shut down. After a few hours, the mice returned to normal—including their performance in cognitive tests—within an hour of normal oxygen levels being restored. If this process can be carried over to larger non-hibernating mammals—such as humans—especially over longer periods of time, that would be A Big Deal.

Alas, there isn’t yet (as I type) evidence that human hibernation is possible. If it is, I wonder how this solution would compound the

¹² “The human body contains trillions of microorganisms—outnumbering human cells by 10 to 1. Because of their small size, however, microorganisms make up only about 1–3 percent of the body’s mass (in a 200-pound adult, that’s 2 to 6 pounds of bacteria), but play a vital role in human health.”

For the complete article, “NIH Human Microbiome Project defines normal bacterial makeup of the body,” see <http://www.nih.gov/news/health/jun2012/nhgr1-13.htm>.

¹³ “Super-bacteria are growing in space . . . and we’re the ones breeding them,” Meera Senthilingam, CNN, October 1, 2014, <http://www.cnn.com/2014/10/01/health/super-bacteria-growing-in-space/index.html>.

¹⁴ That said, small reductions in body temperature may lead to useful savings. Days after the symposium, word came that NASA planners of 180-day (each way) Mars trips are investigating “therapeutic torpor” (to the 89–93°F body-temperature range). The prospective benefit: a reduction in mission consumables from 400 to 220 tons.

Of course to date, no one has spent more than a week in hypothermia and sedation, getting nutritional support all the while through an IV. Nor (in the scenario that the process can’t safely be extended) has anyone gone through the cooling/sedating-and-reviving process over and over and over. . . .

See “Making the long trip to Mars? Let NASA put you in a deep sleep,” by Anthony Domanico, *CNET*, October 6, 2014, <http://www.cnet.com/uk/news/making-the-180-day-trip-to-mars-let-nasa-put-you-in-a-deep-sleep/>.

problem of preventing bone-mass loss. It's difficult to vigorously exercise in one's sleep.

And on the other side

What about the alien life to be encountered at the end of the journey?

Because we should anticipate extraterrestrial life whenever an interstellar mission sets its sights on a world with a breathable atmosphere. Oxygen is highly reactive. That's why metal rusts. A planetary surface rich with rust—iron oxide—has given Mars its characteristic ruddy color.

The only way to sustain an oxygen-rich atmosphere is to endlessly replenish the oh-two supply. On Earth, that process involves cyanobacteria.

There's little reason to expect life on another world will be Just Like Us.¹⁵ That said, there's no reason why alien life can't have *some* similarities. For example, biogenesis elsewhere may have favored the same common chemical elements—e.g., carbon, hydrogen, oxygen, nitrogen—that proved workable on Earth.

David Almandsmith observed that amino acids, the basic molecular components of terrestrial life, are often found in meteorites. For that matter, many organic compounds (and *organic chemistry* literally means carbon-based), amino acids among them, have been remotely sensed in distant nebulae. That's not to say amino-acid-based alien life must use the same amino acids as earthly life. Human biochemistry relies upon twenty distinct amino acids (or 22, or 23, depending which source you credit), but the gamut of possible amino acids (again, exact numbers varying by source) reaches well into the hundreds.^{16, 17}

Physician. Former astronaut. Woman with a mission.

Starships will happen, *if* they happen, only by a great undertaking. At best, we are at the very beginning of that effort. We'll never see the end without a broad community of support. We'll never assemble a viable mission without a holistic approach, encompassing everything from propulsion and energy storage to how, light-years from Earth, clothing is produced and laundry gets done. Not to mention without first answering a host of life-science questions. . . .

That's where the 100 Year Starship organization comes in—not to launch a mission to the stars, but to lay the groundwork.

For a more complete look at 100YSS, its aspirations and priorities, I sat down with its principal, physician and former astronaut Mae Jemison. She is a tireless, intense, and infectiously enthusiastic advocate of the mission. I won't offer many verbatim quotes—she speaks *way* faster than I can scribble notes—but rather the distilled gist of our conversation. My (synopsized) questions are in *italic*.

Why starships? We have yet even to establish a permanent lunar presence. We've been to the Moon. A Mars mission wouldn't be easy to accomplish, but still we can imagine one. To pursue the extraordinary, and to inspire new generations—*that* requires a tougher goal. As we saw with the Apollo program, when we tackle truly challenging goals, our progress comes faster.

(Continued on page 29...)

¹⁵ See my "Alien Aliens: Beyond Rubber Suits," in the April 2013 *Analog*.

¹⁶ Terrestrial DNA uses three consecutive nucleotide bases, each of which can be any of four types (that is, a three-letter genomic "word" written in four genomic "letters"), to encode for the production of a specific amino acid. 4 X 4 X 4 would seem to permit specifying any of 64 distinct amino acids, but that turns out not to be the case. After disallowing reserved combinations (that cellular machinery recognizes as "stop codes" to terminate a related sequence of amino acids) and multiple three-letter combinations that all code for the same amino acid, terrestrial biology gets down to the twenty-or-so amino acids earlier mentioned. The four-letter alphabet appears to be arbitrary, given that cells have been altered in the lab to use six bases (which, sticking with a three-letter word to encode for a particular amino acid, allows many more combinations). See "Hacking the Genome Alphabet," John Cramer's "Alternate View" column in the December 2014 *Analog*.

¹⁷ Many organic molecules, amino acids among them, exhibit "handedness." Mirror-image versions are chemically stable—but not found in earthly organisms. Could alien life use different isomers (molecules of like chemical formula but different chemical structure) than earthly life? Or use left- and right-handed versions at the same time? Unknown.

(One of my favorite interstellar novels is Brian Aldiss's *Starship* [*Non-Stop* in its original, 1958, U.K. edition]. The root cause of disaster aboard a generation ship is the unfamiliar/alien amino acid that taints the onboard water supply.)

Will alien life, even with somewhat Earth-like biochemistry, seek to eat us (or vice versa)? Likely not. People and any life form from an alien world will have less in common than do people and paramecia. How about infecting us? That's also unlikely, though a bit harder to discredit.

None of which lets our hypothetical space explorers out of the metaphorical alien woods.

An escaped-to-the-wild sample of primitive terrestrial life—and starship crew, their crops, and their domesticated animals *will* carry their microbiomes—might out-compete native varieties. Such upheaval at the base of the food chain could throw a native ecology out of whack.

Or some of the metabolites produced by alien life might be toxins—biologically produced poisons—to humans or our microbiome, to one of our crops or its microbiome. . . .

Consider Botulinum toxin. The Illinois Poison Center indicates it is “the most toxic substance known to man. It takes only a tiny amount of botulinum to kill a human. The lethal dose of botulinum is estimated to be 70 micrograms for an adult human (by comparison, the estimated lethal dose of cyanide is 200,000 micrograms).”¹⁸

In like manner, transplanted earthly microbes might exude metabolites that are wildly toxic to elements of an alien ecosphere. Such as, perhaps, alien bacteria that replenish the exoplanetary atmosphere with much of its free oxygen.

Will such inter-biology complications arise? Not necessarily. Perhaps not even likely. But neither are such scenarios far-fetched. The possibility raises issues both practical (how can an interstellar mission prepare?) and ethical (is it moral to put an entire independent ecosystem at risk?).

Rather than try to transplant significant segments of a terrestrial ecosphere to a new world, it might be more practical and ethical to reengineer ourselves. If alien life uses a different amino acid(s), or isomers of a familiar amino acid(s), than terrestrial biology, a change to our genome, or to a tailored version

of one or more of our gut symbiotes, might suffice to convert native food to forms we can digest. (Not that the such reengineering would be a snap. The biomolecular processes of living cells are complex, numerous, and often interdependent.)

The gengineering-ourselves approach—with unintended consequences, of course—underpinned my novelette, “A Stranger in Paradise.”

Dealing with change

Every starship and exoplanet colony will need a health system responsive to the full range of familiar diseases and accidents, but quite possibly also to unfamiliar problems. And yet, the population of a starship, even a colony ship, is apt to be small—“merely” a small-town-sized community will be a challenge to sustain—and yet every possible medical specialty must be represented.

How will that work?

Here on Earth, per Terrence Mulligan, D.O., M.P.H., we have recent experience with re-making medical-delivery systems. How so? The most prevalent adult diseases today, in many countries, are heart disease, cancer, and stroke. Notwithstanding the Ebola crisis (unfolding as I type), these typical modern scourges are non-communicable. Throughout history, until as recently as a half-century ago, infectious diseases dominated medical practice.

The medical community is also adapting to demographic shifts. Young populations have different health problems than older-skewing populations. Urban populations have different health problems than rural populations. Around the globe, populations are skewing older and more urban. . . .

Thirty years ago, only five countries recognized emergency medicine as a medical specialty. Today, 55 have EM systems and more such systems are being deployed. The Global Emergency Medical Initiative is developing methods by which to start up and deploy a national-scale EM system within ten to fifteen years.

Perhaps in setting up a healthcare system for starships and deep-space colonies we'll build upon these recent terrestrial learning experiences.

* * *

¹⁸ <http://ipcblog.org/2011/09/06/mother-natures-most-toxic/>

Space medicine— improving life here on Earth

Space is a radiation-intensive environment. Patients on a spaceship don't need to add diagnostic radiation! Spaceships are small (so far, anyway); bulky, power-hungry diagnostic instruments like MRIs would also be problematical. Not surprisingly, therefore, mission planners have an interest in new diagnostic technologies, with ultrasound-based scanning high on the list.

Portable, battery-powered, ultrasound scanners are a boon here on Earth. The International Space Station (ISS) now stocks one.

We've seen that long-term spaceflight brings an increased risk of kidney stones. Because the ISS isn't the most convenient place to have a kidney-stone attack or to undertake (or undergo) surgery, NASA has funded research in pulsed-ultrasound techniques to reposition kidney stones and remove blockages without surgery.

We've also seen that microgravity can adversely impact intraocular pressure. And so, NASA is investigating 3-D ultrasound imaging to infer intraocular and intracranial pressures. A portable, noninvasive tool for measuring these pressures would be handy on Earth, too.

In recent years, genomics—characterization of the genome—has become well established. Personalized genomes are becoming affordable and personalized medicine is entering the mainstream.¹⁹ Proteomics—characterization of the proteins expressed (or not) from a genome—is the next frontier.

That brings us to a presentation by Kurt Zatloukal, of the Medical University of Graz, on the (still nascent) science of metabolomics. Monitoring metabolites in urine, sweat, and other exudations may offer a way to noninvasively detect bodily changes in advance of overt symptoms. Imagine that technology available here on Earth, embedded in a smart-watch-like health monitor.

Second Life and second chances

From Robert A. Heinlein's *Orphans of the Sky*²⁰ to Harry Harrison's *Captive Universe*, the interstellar generation ship whose crew

Physician. Former astronaut. Woman with a mission.

(Continued from page 27...)

All that said? "No one," she said, "would be happier than me to see a lunar base."

Why 100 years? That horizon originated in the DARPA request for proposal, but more than that, 100 years is an appropriate time-frame. Clearly, interstellar travel is unlikely within a few decades—but let the goal extend much beyond the century mark, and it would divorce the goal from any sense of urgency.

That would be unfortunate. This is a mission to inspire an outpouring of scientific and engineering progress here on Earth, for everyone's benefit. As the 100YSS mission statement notes, "pursuing an extraordinary tomorrow will build a better world today."

What do you consider the top accomplishments of 100YSS? Holding three symposia in two and a half years. Broadening the community beyond the original fans. And added with a grin: moving past the giggle factor.

Given your medical background, what do you see as the biggest challenges? Making the commitment to take on the mission. Finding suitable governance models for starships and off-world colonies.

How do you see a starship program being funded and organized? As an international undertaking, not necessarily governmental, because governments don't often take on such long-range projects. Organized virtually around modern communications tools—and evolving as the tools do. As for mission funding, she offered no prediction, noting that financing models change. (Kickstarter, anyone?)

The bottom line: keep an eye on 100YSS. And stay tuned for an interesting one hundred years.

¹⁹ "The Fabulous Fruits of Mendel's Garden," Fran Van Cleave, July/August 2013 *Analog*.

²⁰ *Orphans of the Sky* novelized "Universe" (*Astounding Science Fiction*, May 1941) and its sequel, "Common Sense" (*Astounding Science Fiction*, October 1941).

has forgotten its purpose—and even that anything exists outside the ship—is a staple of SF.

Part of interstellar mission setup will be to establish societal structures that can persist in isolation for years or generations. That's easier said than done. We wouldn't choose the *Orphans of the Sky* precedent, but we might look for social stability in the rugged individualism of another Heinlein novel: *The Moon Is a Harsh Mistress*.

It seems obvious that modern virtual communities and social networks *could* serve as the basis of a technology-enabled, nonhierarchical, highly participatory democracy. Such a distributed, inclusive, transparent governance model might be more robust and resilient aboard a starship than (as so often seen in SF) the authoritarian naval/hierarchical model.

But perhaps not.

In the virtual-worlds service Second Life, a million-plus regular participants interact in many virtual communities. In a survey of thousands of established communities, Lancaster University sociologist John Carter McKnight reports, only five communities had retained democratic governance. Most communities opted for professional (paid, contracted-for) management—and, in instances where the manager lost interest, imploded.

Rather than form freewheeling, tolerant, inclusive communities, like-minded netizens often clustered. Among the like-minded, zoning laws proliferated. Ungoverned virtual spaces, rather than become libertarian oases, were abandoned.

A famous cartoon in *The New Yorker* introduced the meme that “On the Internet, no one knows you’re a dog.” Maybe so, but through behavioral and verbal cues, race, gender, class, and education are often discernable even in avatar-to-avatar interactions. Some Second Life communities have been hostile (to the point of real-world rape and death threats) against newcomers and “others.”

To be sure, a virtual community is an imperfect analogy for a starship community—you

can't opt out of the latter—so extrapolation from this Second Life study has its limits.

It seems prudent to consider as alternative social models the types of communities that have proven stable despite isolated and harsh conditions. Among candidates McKnight mentioned were indigenous populations (e.g., Inuits), Antarctic research staffs, and nuclear submarine crews.

The takeaway: social engineering is as mission-critical as propulsion engineering. Between stars is a dangerous place to be testing the length of our “genetic leash.”²¹

Don't be a stranger

Faced with the complexities of mounting a round-trip mission to Mars, some advocates of exploration have proposed one-way expeditions. Not suicide, but colonization.²² How much stronger is the case for one-way missions to the stars?

Of course, we already maintain communications between Mars probes and Earth. Armchair adventurers can observe—and will someday, perhaps, buy reality-TV subscriptions to fund—exploration of a neighboring planet. Who will invest in interstellar missions if all that is discovered—even the knowledge of whether a journey was completed—must remain unknown?

Fortunately, there may be a way to maintain contact across interstellar distances. What we need is a *really* big lens in space. As it happens, we have one.

The Sun.

Glossing over the details from general relativity, any large mass significantly curves nearby space-time. Like a familiar glass lens, that curvature bends the path of light rays. Such gravitational lensing has become an important tool of astronomers. Unlike a glass lens, which works in visible wavelengths, a gravitational lens acts on all electromagnetic radiation, including radio waves.

Rather than (as an astronomer might) exploit the mass of a distant galactic cluster to magnify

²¹ “The genes hold culture on a leash. The leash is very long, but inevitably values will be constrained in accordance with their effects on the human gene pool. The brain is a product of evolution. Human behavior—like the deepest capacities for emotional response which drive and guide it—is the circuitous technique by which human genetic material has been and will be kept intact.”

So wrote sociobiology founder Edward O. Wilson in *On Human Nature*.

²² “A one-way trip to Mars,” Kera Rennert, *CBS News*, May 22, 2014. <http://www.cbsnews.com/news/a-one-way-trip-to-mars/>.

the image of some yet more remote galaxy, why not position a communications relay such that the Sun focuses and magnifies signals from a starship? The not-so-minor wrinkle: our lens's focal length. A dispersed-with-distance incoming signal beam, skimming the surface of the Sun, comes into focus more than *forty billion miles away*. That's where the relay must be.²³

But once we *can* station a relay at that distance, directly behind the Sun along the line to the outbound starship, the comm link can achieve tremendous amplification. With our Sun as a lens—the more massive the star, the more powerful the lens—gains of a 100 dB or more are practical. In terms of signal-power gain, that's a factor of ten *billion*.

Once a starship reaches, say, Alpha Centauri, the explorers can (comparatively easily) deploy a relay station to that star's anti-Sunward side. Thereafter, the two solar systems will share a robust two-way comm link.

By our bootstraps

Once we know how to design a starship, how does its construction come about?

We probably won't build it on Earth and lob it complete into space: lifting all that mass against Earth's surface gravity seems prohibitive. We're more likely to build starships in space, from resources already there. At the Earth-Moon Lagrange points, where (relative to Earth and Moon) the gravitational attraction of those worlds balance, smaller objects—such as a ship under construction and living quarters for the construction crew—can maintain a stable position.²⁴

The construction and mission crews will likely come from Earth. Ditto lots of specialized equipment—if not many components of the starship itself, then equipment with which

to build in-space manufacturing facilities. That in itself will entail delivering a great deal of mass, and it may take a space elevator to make lifting so much mass into space affordable.

(A space elevator? It's just what it sounds. Rather than rocket into space—carrying fuel to carry the fuel to carry yet more fuel . . . to carry a comparatively tiny payload—creep up a *long* cable in an elevator car. The elevator ride will take days, not minutes, but it will be far more economical, and far more environmentally friendly, than rocketry. First proposed in 1895, the space-elevator concept was popularized by Arthur C. Clarke in his 1979 novel, *The Fountains of Paradise*.)

Some raw materials for the starship might come from captured-to-orbit asteroids. More might be gotten from the Moon. Given the Moon's comparatively weak gravity, about one-sixth that of the Earth, we'll likely see a space elevator there before we see one on Earth.

Is a space elevator practical? Not yet. Single-walled carbon nanotubes, many times stronger than steel, *might* be strong enough to make a cable reaching all the way to geosynchronous orbit, roughly 22 thousand miles overhead. Alas, the longest single-walled carbon nanotubes yet made measure no more than several centimeters. There's something of a materials-science challenge to be overcome.²⁵

On the heels of the materials challenge comes the radiation problem: the space-elevator car creeping along its cable will spend days within the Van Allen Belts. Before passengers ride these vertical rails, we'll need to execute yet another massive engineering project: clearing the Van Allen belts of their eons-long accumulation of charged particles.²⁶

Such an undertaking would mean, among its effects, the elimination of auroras. Try to

²³ See "Interstellar radio links enhanced by exploiting the Sun as a Gravitational Lens," Claudio Maccone, http://www.researchgate.net/profile/Claudio_Maccone/publication/222558702_Interstellar_radio_links_enhanced_by_exploiting_the_Sun_as_a_Gravitational_Lens/links/00b7d53b09c4947df3000000.pdf

²⁴ http://en.wikipedia.org/wiki/Lagrangian_point

²⁵ Post-symposium, a new contender for a space-elevator cable hit the news. Diamond nanotubes appear to be stronger than single-wall carbon nanotubes. Alas, like nanotubes, the largest diamond nanotubes so far produced are also mere centimeters in length. See "Scientists Might Have Accidentally Solved The Hardest Part Of Building Space Elevators," Ajai Raj, October 13, 2014, *Business Insider*, <http://www.businessinsider.com/diamond-nanotubes-make-space-elevator-2014-10>.

²⁶ "Hacking the Van Allen Belts: Could we save satellites and astronauts by wiping out the Van Allen belts?" Charles Q. Choi, February 26, 2014, *IEEE Spectrum*, <http://spectrum.ieee.org/aerospace/astrophysics/hacking-the-van-allen-belts/>.

imagine the Environmental Impact Statement to be filed for *that* project.

So, far-fetched, right? Maybe not. Obayashi Corporation, one of the largest construction firms in Japan, has aspirations to deploy a space elevator by 2050.²⁷

Why it matters, here and now

That was a *lot* of daunting challenges.

Why would we even *think* to attempt an interstellar mission, much less strive to see a starship launch within a century? Don't we have enough challenges here on Earth?

Because (echoes of JFK's Moon speech intentional) the undertaking *will* be hard. Because the science and technology the quest must inspire—certain to include medical breakthroughs and eco-management insights—will, first and foremost, benefit everyone on Earth.

Economists, employers, and educators alike regularly bemoan a shortage of science, technology, engineering, and math (STEM) specialists.²⁸ The excitement of a Moon race once drew thousands of young Americans into STEM careers. Many of those workers contributed to the Mercury, Gemini, and Apollo programs—whose spin-offs went far beyond Tang. Others brought their knowledge and enthusiasm to the broader economy, and we *all* benefited from that.

As much as a pathway to the stars, 100YSS is about inspiring generations of young people to see science and technology as the pathway to a better life for everyone on Earth.

Wrapping up

Becoming an interstellar civilization will require sustained effort and substantial investment. It will stimulate developments in science and technology, with spin-off benefits first and foremost here on Earth.

What do the difficulties portend for interstellar science fiction? Good things! Storytelling thrives on challenge.

And because science thrives on good SF, 100 Year Starship chose Science Fiction Stories Night at the 2014 symposium to announce a new award program. The annual Canopus Award for Interstellar Fiction will recognize achievements in literary fiction at every length, on television and in movies, and in video games.²⁹ ■

To read further

1. 100 Year Starship (<http://100yss.org/>).

2. And a few likeminded organizations:

Icarus Interstellar (<http://www.icarusinterstellar.org/>).

Tau Zero Foundation (<http://www.tauzero.aero/>).

Centauri Dreams (<http://www.centauridreams.org/>).

3. International Space Elevator Consortium (<http://www.isec.org/>)

4. *Starship Century: Toward the Grandest Horizon*, Gregory Benford and James Benford, editors. Papers written for this mixed fact-and-fiction anthology (does that remind you of another publication?) served as the basis of 2013's Starship Century Symposium.³⁰

5. *Using Medicine in Science Fiction: The SF Writer's Guide to Human Biology*, Henry G. Stratmann, M. D.³¹

About the author

A physicist and computer scientist, Edward M. Lerner toiled for thirty years in the vineyards of aerospace and high tech. Then, suitably intoxicated, he began writing science fiction full time. When not prospecting beneath his sofa cushions for small change for his first space-flight (or at rest upon those cushions, practicing hibernation for his first interstellar trek), he writes technothrillers like *Energized* (power-sats), the InterstellarNet adventures of First and Second Contact and, with Larry Niven, the *Fleet of Worlds* series of space operas. Ed's website is edwardmlerner.com.

²⁷ <http://www.cnet.com/news/japanese-company-plans-space-elevator-by-2050/>

²⁸ See, citing a recent Brookings Institute study, "Report Claims HUGE Shortage Of STEM Workers," Jonah Bennett, July 1, 2014, <http://dailycaller.com/2014/07/01/report-claims-huge-shortage-of-stem-workers/>.

²⁹ <https://100yss.wufoo.com/forms/m1beus1917g8yva/>

³⁰ See John Cramer's "Alternate View" column in the December 2013 *Analog* for an overview of the Starship Century Symposium.

³¹ Dr. Stratmann graciously reviewed a draft of this article and suggested clarifications to the life-sciences-intensive material.



Illustrated by Tomislav Tikulin

The Daughters of John Demetrius

Joe Pitkin

Mendel had run the whole day in his graceful, tireless way, southerly down the road that some called Old Mexico 45 and the locals called *El*

Camino de San Juan Demetrio. There had been little water all day, just a single dusty rivulet past noon where he had drunk and where he had tried without much success to

wash the crusted blood out of his tunic. Mendel was dark enough that it would do him little harm to go naked in this Sun, and he even considered such a possibility, but it would have scandalized the local *vulgaris* more for him to have walked naked into a village than for him to have appeared in a blood-stained tunic.

Mendel came upon such a village at the end of the day, only an hour's run over mesas from the main road, a rammed earth wall guarding an inner circle of adobes and ancient shipping containers. The sign hung above the arch of the outer wall said *Pozos Desecantes/Desiccant Wells*. It had the sloppy look of an old gringo settlement, though Mendel could not be sure on this mesa an hour from the far-off stretch of the road that the gods hardly ever traveled.

He walked through the open gate unchallenged except by a troop of scrawny clucking hens. Most of the central square was taken up by a dusty yard where crust-skinned children in homespun shirts and loincloths carried out a listless game of Chihuahuan-rules football. They seemed not to notice him. Beyond, the adults congregated around a cluster of worn stone troughs, beating the dirt out of their sullen piles of laundry.

Mendel walked to the edge of the game and watched the children. In those moments before anyone in the village noticed him, his eye fell on one different from the rest, perhaps eight years old, her dark skin pristine as the flesh of an avocado. No pellagra with this one. He would have run all the way to Oaxaca to find another like her.

They noticed him then. The children went silent and marveled. Then one mother less exhausted or more anxious than the rest turned to regard the newly quiet children, and she saw divine Mendel in his sweat-glistened lumenescent beauty. He was so beautiful, or they were all so bone-weary, that no one screamed at this bloodstained stranger who had walked unopposed into the heart of the lost little village.

Mendel knew that he must be the one to speak first. He asked in Spanglish in his clear high voice whether the villagers spoke Spanglish or Spanish or English. One of the adults, perhaps the head woman, said they spoke all three. She answered in English as they nearly

always did, always assuming that the gods spoke English, and always following the ancient Mexican law of hospitality that demanded the visitor be made most comfortable. If these people were gringos, they had at least learned this much from the land that had taken them in.

"I am following the road of John Demetrius," Mendel said to them, "and I would be grateful if I could spend the night here." This was not, in fact, so different from Mendel's plans, but regardless of his plans, this was what he always said when he traveled through this part of the world.

The head woman bowed and spread her arms wide in the heartbreaking theatrical way they always did, as though to offer Mendel their whole forsaken village. Then she began ordering the younger adults in Spanglish to begin preparing a place for him; with one of them, a gaunt hardscrabble woman of about thirty, or maybe fifty, the head woman exchanged some brief taut words that even Mendel could not quite hear.

They had never heard of him, he was sure. They had never spoken to travelers from another village where he had wandered. If they had, they would have learned to boil their corn in ashes and these children would not be half-dead from niacin deficiency. As they shuffled about to find a shipping container for him to sleep in and to bring him an ancient cut soda bottle full of rusty water, Mendel looked around again for the beautiful green-skinned girl. But she had disappeared. Another girl, smaller and wretched, stood before him fearlessly, staring at him relentlessly before Mendel noticed her.

Mendel knelt down to look her in the eye. "*Y tú? Cómo te llamas?*" he asked in a conspiratorial tone, as though she would be giving away a secret to tell him her name.

The girl stared at him as though mute. But the gods are imperturbable, and Mendel only looked back at her with the serenity of someone beyond hunger or thirst. They stared at one another a minute or more before the gravelly hen's voice of an old woman shouted in their direction: "*Floribunda! Inútil! Trae aca your scrawny ass!*" The girl spun around as though the words were a leash the woman had jerked; the girl ran in a dusty pad-footed way toward the squalling voice.

The villagers put Mendel up in a clean-swept, well-ordered shipping container, painted turquoise and salmon and bearing the name “Coper” in tawdry letters of rhinestone appliqué. The woman who opened the house to him said nothing beyond “here you have your *pobre casa*,” but whether her silence was resentful or the reaction of a broken woman cowed by the presence of a god, Mendel couldn’t immediately tell. The four children like shriveled rag dolls seemed cowed by him. He decided in that moment that he would give the knowledge of preparing the corn to this family only, as payment for their putting him up for the night. Señora Coper would be one of the most important people in the village, if not the headwoman, for passing along the secret. And she would pass it along, because he would warn her that he would return in wrath and vengeance if she didn’t.

She served him cornbread on a plastic bucket lid, and he weighed the silence carefully before he asked them to what family the green-skinned girl belonged.

“She is Lupe Hansen’s daughter,” the woman replied with a wary eye on him every moment, as though she knew why he was asking, though of course she didn’t.

“You know she is a child of San Juan Demetrio?” he said.

“We are all children of San Juan.”

At this, Mendel thought it wise to say only “Indeed, *así es*.”

None of the children had taken their eyes off of him. The smallest, with eyes like shining black olives, was the first who dared to speak. “*Pero por qué estas bloody?*”

“César!” the woman hissed, scandalized. But Mendel held up his hand to the woman to gesture that he was not offended.

“I was in a fight.”

“Did you die?”

“No—if I had died I would not be sitting with you here.”

“Were you hurt?” asked the oldest.

“*Un poco*. But my body recovers *muy rapidamente*.”

“Who did you fight?”

“An evil god,” Mendel answered. “A god who didn’t like people.”

The answer seemed to awe the children. But the woman, who seemed too mortified to

notice the children’s reaction, added for good measure: “*Es un god muy malo*, who will take you away if you don’t stop asking questions.”

The next morning all seventeen children in the village had questions about the evil god. Mendel regretted a little his explanation of the night before, though of course someone was bound to have asked him about the blood stains and, as was typical of Mendel, he had spent the previous day telling himself that he would need a good story instead of actually coming up with a good story. He told them that the god he had bloodied had hated the natural people, had wanted all of the natural people to take on the bodies of demons and to fill their minds with the nonsense of dreams. The children seemed to regard this explanation quietly and utterly without skepticism, which suggested all the more to Mendel that what he said was strictly true. Yet, on account of their pellagra, they showed none of the awe that children of the other villages had; they sat stooped and downcast like feverish hallucinators, their crusted hands held out before them like barnacled flippers.

The flawless green girl stepped up to the circle of children as artlessly as a little deer. Studiously, Mendel continued his tale: He told how the evil god had stolen many children for his terrible purposes (pure fabrication, but Mendel could not resist their attention, even limp as it was). But Mendel loved the natural people so much that he risked himself to save them. The green daughter of Lupe Hansen watched him, and he observed her without ever looking directly at her; he felt her watchful presence as though soon she would eat from his outstretched hand.

But the children were called to school by a long cracked note from an old trumpet, and Mendel watched them all, from the green girl to the most encrusted lad, retreat to a cluster of four shipping containers at the edge of the houses, like a square bounded by the larger circle of the village structures. The one who blew the trumpet was a woman somewhat less slack than the rest, without pellagra, with a faint tint to her skin that announced to Mendel that she was Lupe Hansen.

Mendel rose from the ground where he had sat cross-legged, and he noticed only then that not all of the children had quite retreated. The other girl, the one called Floribunda, stared at

him still. He found her look a little hostile. Or perhaps terrified. But just when Mendel decided that it must be terror that made her look at him so, she held out to him a tiny green wisp of locoweed, which he took from her before she ran after the other children to the school.

While he waited, Mendel busied himself with helping around the village. The village technical council, three craggy-faced men, came to him like a humiliated embassy offering surrender. "Our *molino* runs poorly; we believe there is a short in the photovoltaic system," the most venerable of them said.

"Perhaps the film needs cleaning," Mendel answered. "The village is very dusty."

"Perhaps," the man said with pained courtesy. "But we have tried to keep the films clean."

The films were in fact scrupulously clean. The village technical council had guessed correctly about the short, which Mendel found buried in the adobe wall where the old man had thought it might be. He peeled the wire out like an intransigent root from barren earth, and he wondered why the old men had not trusted themselves enough to find the short themselves with their antique voltmeter.

Mendel visited Lupe Hansen at the school after the children had cleared out to play Chihuahuan rules football. "Do you know who I am?" Mendel asked her.

She did not look up from stacking the children's tablets. "You are a god."

"But do you know who I am?"

She stopped to look at him. "No. I know only that you are a god."

Mendel approached from another tack. "Do you know that your daughter is *bija de* San Juan Demetrio?"

"*Sí. Así es.*"

"You are also one."

"*Sí. Así es.*"

"Why did you never go to Phoenix?"

"This is my village."

"Have you never thought to send your daughter there?"

The woman said nothing. When she lifted the stack of tablets to put them away, Mendel saw a tension in her shoulders, what he took to be stubbornness, though he knew he was not so godlike as to be above projection.

"Your daughter could be schooled in ways that you know you cannot school her here," Mendel continued. "She could come back to Desiccant Wells as a god, and yet as one of you as well."

Lupe Hansen began scrubbing down the students' tables with a dusty rag.

"Your students could use those tablets to get to the real internet, if you had a guide," he said, pointing at the stack of tablets as though the woman was also looking at them, and not intently at the dusty tabletops. "It is the ones like your daughter that will bring reunification."

Lupe Hansen's mouth was set as she scrubbed at the tables.

"What is your daughter's name?"

"Chloe."

"Chloe would be a god," he said as reverently as an evangelical missionary.

Lupe Hansen said nothing but looked directly at him with a pain that seemed both powerless and impervious to reason.

It offended his sense of dignity to wheedle for the girl. For every parent that handed over a child to him without flinching, seeing the benefit of entrusting a child to the care of the gods, there was another like Lupe Hansen, for whom the benefit Chloe might receive would not justify separating her from her mother.

He stared back at her, and unlike so many natural people Lupe Hansen was not awed into looking away. But of course, she was no natural person, either—otherwise, why would Mendel be bargaining with her over her daughter?

It occurred to him, with some relief, that he had not told Señora Coper the secret of corn nixtamalization. "If I could cure everyone in the village of their sickness, would you let Chloe come to school with me? Please consider it." And with that he walked out of the little school and past the water troughs and the solar ovens, where he said to the headwoman that he would return the next morning to Desiccant Wells.

He ran out into the desert a safe distance, back toward Old Mexico 45 where no one would have been shocked to find him. Safety was relative, of course: Perses had had friends, *shedim* and *lilin* who certainly would know of his death by now. And when their suspicions fell on Mendel, Old Mexico 45 was one

of the places Perses' friends would think to look for him.

But he was safe at least from the villagers' attentions for a moment. He closed his eyes and linked up with the satellite, got lost a few hours in his mails—mostly advertisements clouding up his neurons. He tried to get in touch with Handy, which had been his purpose linking up in the first place: did he have room for a little green girl, unusually quiet and, so far as Mendel could tell, totally untrained? Mendel found it half charming and half infuriating that Handy, who could stay linked up the livelong day if he wished it, had an old-fashioned autoresponder on his account like some telephonical answering machine from another age.

Mendel took a risk and accessed one of his thoughtbank accounts he had squirreled away. None of his acquaintances knew about the account, and he doubted any of Perses' cronies had tried hacking into Mendel's internet history yet. Just over three hundred new dollars sat there beneath anybody's notice. Lying on the baking hardpan in the flimsy shadow of the creosote, he closed his eyes and moved, quickly and quietly, a hundred dollars to a terminal in Delicias. Then he logged off and delinked and, in the heat of the day, ran two hours southeast down Old Mexico 45.

In Delicias, at the *Hotel Vieja Delicias*, Mendel checked in as Conrado Hermés, paid with N\$61 from the terminal. Nobody asked him about the bloodstains. Delicias was one of those towns where the naturals had some exposure to the divines and treated them with deference but not awe. The hotel clerk, whose nametag said "César," was young enough and beautiful enough that he might have passed for a god, but Mendel could tell by his genetic summary—or, more properly, his lack of a summary—that he was as natural as Floribunda and would be handsome a few years more at most. With the rest of the hundred new dollars he ordered a fresh tunic, six *tacos de suadero*, and three liters of *Ambrosia* beer, and he slept that night in a bed that bore some resemblance to the bed of a god.

On waking, he felt again the perfect confidence that he would walk out of Desiccant Wells with the child of Lupe Hansen. The

night's sleep, the revitalizing *Ambrosias*, the brilliant white tunic all convinced him that success was a foregone conclusion.

Then, walking out of the *Hotel Vieja Delicias*, he saw a *lilith* snooping about as she came up the road, peering into windows, swiveling her half-snake head to and fro like a flashlight. Mendel had worried about the blood on the old tunic. It wouldn't have hurt him to have worried about it a little more. But he had thought it unlikely for one like Perses to carry radio tags in his blood like a child or a criminal. Mendel's main worry had been that the bloodstains would frighten the naturals.

The *lilith* was a good way up the street, moving past a trio of *vulgaris* hauling an enormous handcart toward some market or warehouse. Mendel was the only other divine on the road; she would spot him for sure if he began to run. To his left a laundromat operated out of a family's garage. He turned into it as though that had been his errand all along.

A broad-faced natural with a thick braid of hair in the ancient style looked up at him from the pile of laundry her neighbors had left for her. Mendel wondered for half a second whether the old bloodstained tunic was in the pile, sent over by the hotel to be washed instead of incinerated as Mendel had demanded. He raised the back of his hand to her like a strange greeting; his fingernail, tapered and sculpted, began to grow out of his index finger into fifty fatal centimeters of talon.

"Is there a bloody tunic in your laundry?" he asked in Spanish.

"No, lord," she answered, emotionless.

He sheathed the claw back into his hand. "Is there a back door?"

"It leads to our house, lord."

He asked if he could get to the roof by that way. He could. For a short, waddling woman, she moved in a hurry, and silently, and he followed her into a dusty cinderblock courtyard with a legion of geraniums growing in old rusted cans. The lip of the roof hung three meters or so above the ground; Mendel leapt, caught the lip, and vaulted himself up. He looked back at her only a moment to say in his antique Spanish: "From this day the gods bless your house." Then, with the same finger that a moment before had been a blade of

finger nail, he exhorted her to be silent. He stayed not a moment to see her bowing deferentially, but like a loon lifting off from the water he glided across the roof and leapt into the street behind, and then he ran faster than any *lilith* deep into the mirages of the desert.

He took a roundabout way back to Desiccant Wells, running far to the west into the creosote and circling back southeast. It was nearly noon when he arrived, and a call went up when he came into sight of them. By the time he walked into the central courtyard they were arrayed in front of him in all their scabby glory like a choir. In the center of the formation, looking more desolate even than the day before, Lupe Hansen stood with her arms draped protectively over her daughter before her. Yet at the girl's feet was a backpack, and she stood dressed and washed and combed like a lamb for sacrifice.

The headwoman was the first to speak, "Will you, lord, cure us of our sickness?"

He showed them the trick with the water and ashes that would soften the corn kernels, that trick which even the poorest village in Mexico would have known in the last age, that trick which in fact had been discovered not far from Desiccant Wells nearly four thousand years before. As far as the villagers were concerned, Chloe Hansen was a fair trade for such knowledge.

During the celebratory dinner, the little girl looked at him balefully and silently. If she had cried on learning that she would go with him, or if she was to cry about it later, she wasn't crying now. Of course, Mendel had taken the other children whether they had cried or not. But it was always easier for him if they didn't cry.

The Sun was low before they were ready to set out. The headwoman and others clamored for him to stay one more night, to leave in the morning—give the girl one more night with her mother. But the girl would be safe at night, Mendel assured them, and no marauder on the road would be so foolish that he would try to steal a child from a god.

They relented at last, and as the Sun was setting, he hoisted the little girl with her backpack full of undoubtedly useless things. He left at a loping, gliding pace, not wanting to jar the poor child more than necessary as she wept silently on his shoulder.

Or not so silently. Before he had run a kilometer, he heard the child's racking breathless sobs. Only, they came not from the girl on his shoulder: He looked back to see another child who had run after them, who had covered only half the distance and now stood alone on the empty mesa in the gathering night. The twilight had darkened so that he had to double back to see who was there. In her threadbare loincloth and dusty as an unearthed root, Floribunda stood wheezing and snot-nosed and miserable.

"You have to go back to your parents," he said to her. "I can't take you with me."

"*No tengo* parents," she gasped. "I am *bija* de San Juan Demetrio."

"Who cares for you in the village? They are worried for you right now."

"I am *bija* de San Juan Demetrio."

The gesture he made, running a hand through his hair while he looked down at the problem she represented, was the gesture any god, or any natural, might make in answer to a stymie. He might scoop her up and carry her back like a sack of meal, if he could put up with the indignity of returning, of appearing before the *vulgaris* like one of them, like some harried uncle with a kicking child under his arm. Or he could leave her. She might return to the village on her own.

He considered the problem longer than he intended to, staring a full minute at the impediment before him. Floribunda looked neither at him nor at Chloe but rather kept her eye on the purple and green horizon with a grim intensity, like the captain of a little ship in the open sea.

Then he saw another shape far off in the failing light. But moving quickly: low to the ground on four feet, head thrust forward like a jackal, limbs sweeping along double-jointed and implacable it came toward them. It was the *lilith*.

He scooped up the other girl and ran. He moved like a gazelle even with the two under his arms, though he ran with an effort that was unfamiliar to him. He ran toward the line of mountains far in the west, a kilometer, two kilometers, three. But soon enough he could hear the *lilith* scrambling not far behind him over the hardpan, tearing the creosote from its roots when she juke to match his turns and scrambles.

Both girls had fallen silent. With an instinct that had been honed in some ancestral mammal from a prehuman epoch, they had drawn in their limbs to make of themselves tight bundles that Mendel grasped, one under each arm, like two lean footballs. But he knew after a few minutes that the *lilith* was outrunning him, that any moment he would feel the shock of her jaws around his Achilles tendon, and he would go down.

He cast the girls to either side, into the creosote and tamarisk. They flew from his arms silently, but before they crashed into the bush Mendel had spun about with the blade of his finger spiking like a chitinous rapier.

But she was faster than Perses had been, and she had known what to expect from Mendel. The *lilith* cast herself wide of his arm, wary as a dog, and from her fangy mouth she spit at him, something hot and corrosive that seared his arm and shoulder.

She had scrambled past him and turned to face him again, just out of reach of his talon, and Mendel saw that when she spit at him her mouth contorted like one about to vomit, and the acid shot from beneath her tongue in two streams. He dodged, and, spinning like a dancer, he leapt at her, throwing his arm wide to slash. But she too was fast and leapt back beyond his reach, and once more, he felt the searing stream cross against the skin of his midriff.

The pain blinded him, or would have. But he had been blessed with a divine measure of endorphins in times of agony. In that timelessness brought on by death whispering in his ear, Mendel considered what he might do differently to get at the body of this spidery woman, her elbows and knees all angles as quick as Mendel Hodios could manage, almost as quick as Mendel even at his strongest. It was he who dodged and leapt back now, keeping always her stream of venom from landing on his flesh.

He did not know this *lilith*. Her hands and feet looked slender, not for crushing, though he had been fooled by slim hands before: He had seen more elfin hands than hers choke the life out of a full-grown *vulgaris*. Perhaps it was her jaw that would crush him, or her sinewy legs, when the venom finally wore him down. Her tactic would be the last thing he discovered, or he would never discover it at all.

He crouched to face her, his sword held above him like a scorpion's sting. She crept sidewise before him on the tips of her fingers and toes—he concluded that yes, her fingers were surely strong enough to break him if she should lay a hand on him.

A rock struck her head from behind, bounced away. Close behind the *lilith* he saw Floribunda, recovering her balance; the rock she had heaved had been the size of a loaf of bread. But the *lilith*'s head twitched, no more than that, no more than a flinch at the annoyance of being struck by a rock that would have crushed a natural's skull.

Mendel knew then that he was likely to die. The two girls would, too, if the *lilith* had it in her head to bring harm to them. The *lilith* reared onto her legs a moment, her mouth widened in the now-familiar grave contraction.

Mendel took his fatal chance and did not dodge. A stream of the venom splashed his chest and funneled down his breastbone as he leapt at her. But, as he had hoped, aiming her venom took some concentration: One thing she had not expected was that an enemy might leap to embrace her just as she vomited her poison. He too was stronger than he looked: she fell back in his arms, just as the spike of his finger slid into her side, under the ribs.

He felt himself weakening, his body straining to respond to the acid devouring his skin, the systems going into shock, his heart chattering, his thoughts scrambling in the fog. Yet he retained the presence of mind to know that the *lilith* had gone weaker still: He could see the tip of his fingerblade sprouting from the other side of her body, the blood draining from her in great sheens down her legs. Her face showed neither panic nor suffering but rather an impregnable calm.

And then, he could hold her up no longer and she fell back, and he also, a moment later. The sky was purple above him. He heard a rushing sound that might have been the wind, or perhaps a sound coming from within him. The pain hammered.

A minute later, or perhaps five, perhaps after he was already dead, he heard the two girls breathing above him. He heard the zipper of the little green girl's pack. Then a trickle of water into his mouth, ambrosia.

"Pour the water over my skin," he said. He was overcome with gratitude that Lupe Hansen had sent her daughter with a three-liter bottle in her backpack. The water ran cold and excruciating over his pulsing, blistered flesh.

The two girls crouched in front of him as he lay on his back. They watched silently like two creatures inured to suffering, or so acquainted with it that they did not consider his agony worthy of comment.

He lay there through the night, his skin howling in the cool of the breeze. When the sky had brightened enough that he could make out their features, the girls still watched him, sleeplessly, the way old women had tended fires for a million years. He could feel the flood of macrophages and growth hormones already released into his tissues; by dawn he was able to hoist the three liter bottle himself, to drain the last milliliters of water into his mouth.

If he could run unburdened, Handy's redoubt lay six hours to the west. As it was, he might walk there with the girls in three days if

water could be found. He had no compunction now about linking with the satellite—the girls watched him and noticed nothing more than that he closed his eyes for a time. If the maps were accurate, a creek ran sixteen kilometers to the west, near the foothills of the *Sierra Madre*.

He logged off, opened his eyes as though he had been sleeping for a few minutes, smiled at the two girls who looked at him like two inscrutable frogs. He pushed himself to his feet and observed the pounding of his head as his humors balanced. Behind the girls the *lilith's* corpse lay staring at the *Sierra Madre*.

He crouched over her body and drank what blood he could from the wound. There was not much left. If her blood carried radio tags, perhaps no one would catch up with him until he was safe at Handy's.

"Now you have to walk with me a long way," Mendel told the girls, extending a hand to each of them. Floribunda took his right hand, caked with the *lilith's* blood. The three of them walked in the direction of the pass, and water. ■

JOE PITKIN

It's not uncommon for *Analog* contributors to start life as scientists and then become writers. Joe Pitkin did it the other way: He began as a writer and then became a scientist.

The son of a literature professor from Utah State University, Pitkin grew up reading classic science fiction and fantasy and watching Carl Sagan host the original *Cosmos* on public television. Not that those were his only interests. "I was reading all kinds of other stuff," he says.

In college, he followed his father's footsteps by majoring in liberal arts, and then getting a master's degree in English—a decision that temporarily cooled his passion for science fiction. That was partly because he was becoming a poet and translating Spanish poems for a poetry journal. (He is also conversant in Hungarian and German, although not at that high a level.) But academia can be hard on science fiction enthusiasts. "In school, I picked up a lot of the prejudices my English teachers had against [the] genre," he says. "It wasn't until my thirties that I went back to the science fiction I loved and realized there was a lot more there than some people gave credit for."

Meanwhile, he'd moved to Vancouver, Washington, where he's worked ever since as an English professor at Clark College. It was teaching, in fact, that brought him back to science fiction. "There was a science fiction and fantasy course in our department that was going begging for a teacher," he says. "I took it because there was no one to teach it, and I had some background in science fiction. Teaching that class, I thought, wow, there is some great literature there."

Simultaneously, his interest in science was resurging to the point that last year, he completed a master's degree in environmental science, studying the regrowth of vegetation on a portion of Mt. St. Helens that had been totally devastated by the 1980 blast. "It's one of the few primary-succession laboratories on Earth," he says, "one of the few places on Earth in recent history where all of the biology was wiped out. We've spent the last 35 years watching it come back."



Photo by Carolyn Eames

Not surprisingly, his interest in biology has infused his fiction. His first *Analog* sale, "A Murmuration of Starlings" (June 2012), involved birds and plagues. His second, "Full Fathom Five" (September 2013), involved alien life beneath the ice of Jupiter's moon Europa. This issue's story is about genetics and the future of humanity. "One of the real, morally complicated issues in science has to do with how we define ourselves and how we are coming to alter ourselves," he says.

The ideal science fiction story, he says, works for the same reasons as any other form of good art. "Good art creates expectations and then violates [them] in a way that is more pleasing than you expected. If a story just ends the way you expected it to end, then what you've read is a bunch of clichés or something that's trading in theories that have [already] been covered. A real piece of art will surprise you with something better than what you hoped for."

Analog stories, he says, are special because they add an unusual degree of science. "One of the things I love about *Analog* stories is their rigor," he says. "The best really pay attention to the science." But they are also good stories. "The writer understands how dialog works and how to achieve an effect with subtlety," he says. "The[y] work as literature and also are scientifically provocative." ■

Butterflies on Barbed Wire

Marie Vibbert

Damien goes to the front of the shop, a room papered in tattoo designs grouped in large chunks—animals to the left, tribal designs to the right, lettering and fonts all along the top and in between things squeezed here and there. Up high on one wall, where children won't be able to get to it, is a flap that says "This tattoo is free" covering a shot of a guy's dick with a tiger on it. It's been up there since before Damien was born, and no one has ever taken them up on the offer. He doesn't know if the tat was done in this shop or is one of those pictures passed around the internet.

An older woman stands eyeing the flap dubiously. She has a leather briefcase hugged to her chest like schoolbooks, and this makes her seem young, but he can see the grey under her red hair dye. "Can I help you?" Damien asks.

She smiles a sales rep smile. As she turns, he sees an animated LED tattoo, a lizard crawling around her right wrist. "I see you don't yet carry Flexi-Print."

"No ma'am," Damien says. "We're just a tattoo shop."

"Flexi-Print is the state of body art today. You're behind the times."

Damien points to the "NO SOLICITORS" sign. "I'd sure love to talk, ma'am, but I've got a customer." The comforting buzz of Grandpa's tattooing in the room behind makes his lie obvious.

She stretches an arm between him and the curtain to the back room. "Let me leave you a sample. You may change your mind."

"Okay," Damien says. "Then go."

She sets her case on the cashier stand and fishes around in it. "I know you don't even have the basic model, but what I'm really selling is this new technology that works off of Flexi-Print. It's called Scrim. It not only displays both animation and still art on your skin, but also real 3D. Imagine a hole in your arm showing your bones or a parrot on your shoulder."

She taps her wrist with a pen, and the lizard pops out of her skin with a rippling animation. It pauses to glance up at him after each circuit around her wrist.

Damien imagines exposed gears inside his arm and a dragon on his shoulder. He takes the silver plastic baggies from her and thanks her.

He cuts back through the workroom without looking at Grandpa and the girl getting her son's name on her neck. He goes through the door that leads from the shop to the house.

Dad and Uncle Ray sit on the sofa watching a documentary about sea life. Damien sits next to Ray because that's where Aubery sat, with her long, fish-white arm touching his. Damien doesn't like to think about other ways they touched, about how Aubery was Ray's wife even before she was Grandpa's apprentice, but even so, he finds himself laying his arm, in its long white sleeve, next to Ray's on the couch. Ray shifts and scowls at Damien. "What are you doing?"

Damien gets up. "I'll start dinner."

"Why aren't you in the shop?" Dad asks, without looking away from the TV.

"Grandpa's got it," Damien says.

He leaves the Flexi-Print samples in the cupboard with the baking supplies. No one else will see them there.

When Damien was sixteen, his father said he could get his first tattoo. Aubery had moved in just a year before. She waited for him to settle into the client chair. "What do you want?" she asked.

His skin tingled with possibilities. "Whatever you want."

"You don't mean that. You've had sixteen years to look at the pictures in the front office."

"I want to see what you'll draw when no one makes you draw something," he said.

For the first time, she really looked at him, like he was interesting to her. "You'll take that back," she said. "I could want to do the tiger."

He pointed to his arm. "Whatever you want. Right there."

So she picked up a pen and sketched a butterfly. She raised her eyebrows at him. He knew she expected him to squirm and complain about a girly tattoo. "Whatever you want," he repeated.

They stared at each other like it was one long game of chicken as she inked in that butterfly. Her hands were good, and her eye for detail and line. The butterfly came to life on his arm in delicate tracery even before she added color. "You're going to get made fun of at school," she said.

"No, I won't. I love it."

She drew deep cobalt lines down from the edges of the butterfly wings, lighter on the front side like a real insect.

The next day at school, he peeled the bandage back carefully while his friends gathered close around the cafeteria table. There was a moment of silence that lasted too long. Frank wrinkled his nose. "Dude," he said.

Like one beast, his friends all dropped back into their chairs, away from him.

"That's a girl tattoo," Liam said.

Jake got up on his chair flapping his arms and singing in falsetto, "Damien's a butterfly! A pretty butterfly!"

Damien's admiration for Aubery's art solidified right then into passionate love for the butterfly tattoo. He stood up. "Forget you guys," he said.

Frank stepped in his way. Damien pushed him. Like the natural pull after a wave hits the beach, Frank pushed back. The fight felt right, even the part where Liam and Jake wrestled them apart.

Dad came to the school in his stained T-shirt that showed too much of his hairy belly. Damien got to go home early and wondered at how it felt like neither a reward nor a punishment. Dad was silent in the car. He pushed Damien's shoulder as they entered the kitchen. "Go on up to your room; you're grounded for fighting."

Their house was (is) like an anthill; human-thickness paths worn through the piled detritus of time and absent people—quilts, teacups, board games. Damien lay on a bed that used to be his great aunt's and watched the bowling trophy and clown lamp, both of unknown origin, rock into each other as his father's heavy steps shook the hallway.

"You're turning him into a woman!"

"Ray! Don't let your brother talk to me like that!"

The hollow-core laminate door did little to block the progression of the argument. Damien looked at the cracks on the ceiling and concentrated on the pleasant burn of his new tattoo.

Aubery pushed his door open so hard the top hinge cracked. "You're coming with me," she said.

Her face was wet and her hand shaking. He let her lead him down into the shop, let

her peel his bandage off and wash away the ointment. With a look of angry determination, she carved barbed wire into his skin. Sharp point after point, she caught the butterfly in it, tore its wing, and made it helpless.

The guys at school preferred this tat. Damien didn't like to see a creature suffer, even an imaginary one suffering imaginarily, but he didn't complain. He'd already decided his skin was hers to do with what she wanted.

Damien wakes up early and takes a shower with the pink soap Aubery used, which is still in the shower since no one will throw away. He watches the bubbles slide over his tattoos. Damien has a vulva tattooed on his inside right forearm. It is open and glistening and not at all stylized.

It was Aubery's last attempt to play tattoo chicken with him. Her face was thin and pale under the thick bandana that covered her bald head. Her eyebrows and lashes had always been pale and wispy, always half gone, but still the fleshy, naked edge of her eyelid was horrifying. She was silent, and he feared a space had opened between them, but when she finished the initial ink, a grin cracked across her cheeks and she said, "I really ruined you, didn't I?" Her hand ran over the lines of previous tattoos, and they kissed and cried.

The tattoo doesn't look like Aubery's vulva, which was darker on the outside and pinker inside and altogether more wrinkled.

Damien wears long shirts a lot. He puts on a second-hand shirt for a baseball team he has never watched or cared about. Long red sleeves.

He goes to the kitchen and sets a pot of coffee brewing with chicory, just how Aubery always did.

Grandpa and Uncle Ray won't come down until they smell the coffee already brewed. Dad won't come down until the day is half over. Damien opens the cabinet for baking supplies so he can make the scones Aubery used to make and sees the silver foil packets from the sales rep.

There is a pretty, plastic-feeling card with instructions and holographic images. Damien

is familiar with the basic concept. Inside the foil packet is a rectangle of white mesh with a sticky backing. You laid this sticky-side down on your skin where you wanted the image to be, and then used a special stylus to push each cross of the mesh into your skin, embedding too-tiny-to-see emitters, like injecting ink for tattoos. Damien can try the display out without injecting it, instead just leaving it on his skin.

He rolls up his sleeves. His first instinct is to cover the vulva. He sets it there, and then immediately pulls it off. The embarrassing tattoo is his, and so is the humiliation, and he doesn't want to lose any of it. He looks briefly at his other arm—at the butterfly caught in barbed wire.

He sits down and lays the mesh on a bare patch of skin above his knee. He doesn't want to cover any of Aubery's tats, not the ones that mean something nor the ones that are just doodles. He loves the doodles best, because they don't mean anything but Aubery.

There's a memory chip that can hold your custom program. Right now it has a demo in it. He pops it into the provided stylus and passes it slowly over the mesh to activate it. The mesh shimmers, and then an orange and blue oval is flipping, end over end, into and out of his thigh. The illusion is only slightly marred by the mesh backing.

It is, in a way, his first tattoo since Aubery's death. He's trying to decide if he hates it for being unworthy of that when Grandpa shuffles in, his slippers scraping on the linoleum.

Grandpa holds a cup of coffee to his face and inhales deeply, leaning back against the draining board. He takes a long mustache-strained slurp and opens his eyes. They immediately track to the colorful animation on Damien's thigh. Coffee spills over the clean dishes as Grandpa throws his mug in the sink. "Where'd you get that?"

"A sales rep," Damien begins. He reaches for the control wand, but Grandpa tears the adhesive film from his skin before he can pick it up.

The logo blinks and sways in the air, hollow on the back as Grandpa shakes it. "We make permanent art. It hurts. It's a part of you. You get buried with it." He slaps the mesh down on the table. The image breaks

into two identical copies, one smaller than the other, rotating into each other like beaters on a mixer.

Grandpa turns back to the sink, his passion deflating. "Shiiit. Look at this mess you made me make." The pieces of the cup clink together as he gathers them.

Damien carefully picks at where the sticky backing has folded against itself.

Grandpa returns to the table with a fresh cup. He watches Damien working to straighten out the sample. He turns it off, so it's just a piece of mesh, like a square of sticky bandage.

"Just throw it out," Grandpa says. "You know I how I feel about that shit."

"It was free," Damien says. "I wanted to try it."

"These candy-asses today. They don't even know what the scene was about."

Damien pushes the wrinkled gauze back into its foil packet. "You do capsule ink," he says.

Grandpa scowls. "The hell! Boy, that ain't even the same thing!" His face is red enough to wash out the dragon that curls around his left eye.

Damien goes back to the baking cupboard and gets out the big mixing bowl. "I'm making scones," he says.

"Thank Christ," Grandpa says, "Finally something useful."

Damien is cutting the butter into the flour when he hears Uncle Ray enter and get his coffee. "Can you believe what your nephew brought into this house?" Grandpa asks.

Damien listens to all the reasons temporary tattoos are evil. He thinks about capsule ink, which they sell. It's just the same as a regular tattoo, but the ink is water-soluble. It sits in microscopic capsules that protect it, but if the owner decides they don't want their tattoo anymore, a quick spray of a certain chemical breaks the capsules and the tattoo bleeds away as quickly as a phone number written in pen.

The embedded projectors are more permanent.

"Stop that," says Uncle Ray. It takes a second repeat for Damien to realize he's talking to him. He turns from his mixture. Ray is standing directly behind him. "Stop making those. Make something else."

He's making the black currant scones Aubery made.

Ray looks like he might cry, and he knows it, and it scares him. "I don't want any more fucking scones," he says.

Damien is frozen, unprepared for a morning without scones. How will his family not fly apart without Aubery's scones and Aubery's coffee holding the center?

"I like to cook," he says.

"Make bacon. Make eggs."

Dad comes stomping down the stairs carelessly like a large weight dropped from the landing above. Everyone turns to watch him enter, and he looks at everyone else.

"Damien, why the hell do you always have to be doing women's work when I see you?" Dad asks.

Damien leaves the half-formed dough on the counter and walks out the kitchen door.

There is nothing in their tiny town other than the tattoo shop, a bar, an old general store, which sometimes opens as an antique shop, and an abandoned gas station. There's a new gas station with a convenience store five miles up the road near the freeway entrance, and, for most people, that's the real center of town.

Damien knows his dad has a sometimes-sexual relationship with Madison, the bartender at Billy and Charlie's. The bar is owned by a man named Mike. He chose the bar name because he thought that two men's names sounded friendly, and he didn't know anyone named Billy or Charlie who could take offense.

It's daytime, and the bar is empty. Madison leans her heavy breasts on the bar top, watching Damien play a simulation he has just written on the Flexi-Print. It's supposed to be Aubery's face, but he hasn't quite gotten her, yet.

"I can select a solid shape, or a point," he explains, tapping the stylus on Aubery's too-round cheek and then sliding it thinner. "You never have to stop changing it."

"That's why your grandpa doesn't like it."

"But I don't even need a device to run the software. It's all included. I can really do this, Madison. Maybe you could talk to my dad about it?"

Madison purses her lips and pulls away from the bar. She busies herself wiping down

the taps. "Truth is, your dad asked me to talk to you about something."

"I don't want to go to the junior college," Damien says. His visit to the local junior college depressed him. There was all that empty hope that knew it wasn't going anywhere but was trying so hard to pretend.

Madison smiles. "No, not about that. Though you should, you know. Get out of this place, somehow." She gives the taps one more thorough wiping each and steps back. She looks guilty. She walks around the bar and takes the stool next to him. "When's the last time you were with a woman?" Her eyes move back and forth, searching for something in his face. She leans closer. "When's the last time you had sex? Have you had sex?"

"I . . . uh, I'm eighteen." He thinks of Aubery naked, skin like paprika sprinkles on egg white. Aubery holding a finger to his lips as she steps into his shower, silently daring him to make a sound. He thinks of Madison with his father, about where her tan-lines end and about the picture when she was younger and had just gotten the star tattoo on her hip, holding her pants down lower than necessary and laughing at his father behind the camera.

Madison pats his hand. "Your father's worried about you. There aren't that many girls your age around here."

"When I'm ready to meet someone," he says, "I know where to go."

Her fingers curl around his wrist as he starts to stand. "You do like girls, don't you?" she asks.

"Very much," he says.

He leaves before she can ask the next question.

Damien doesn't blame his Dad for his mother leaving. He doesn't blame his mother, either. She left because Dad slept with Madison. Dad slept with Madison because he couldn't help himself. Damien understands that.

They are living with Grandpa and Uncle Ray temporarily, until Dad gets his affairs together after the divorce. It's been ten years, and Dad still hasn't gotten his affairs together. Damien does blame him for that. He blames cancer for killing Aubery, and he

blames Grandpa for both his sons being unable to move on or get a job. He wonders about Grandma, and if there was another Madison, or another cancer. She's only a photo in the living room, in a swimsuit, squinting into the sun, the color all faded from age.

There's a photo of Aubery next to it, now. Its wooden frame is the newest, most expensive thing in the house. It looks spliced in by too-sharp special effects.

Damien can't use the model of Aubery when he demonstrates the Flexi-Print to Dad and Ray. In his room, he starts a new file. He will make a butterfly. He pulls up the shapes tool and makes two rectangles to start the wings and a cylinder for the body. Then the heel of his hand pushes the mesh accidentally and because the mesh isn't perfectly on its slick backing it wrinkles. One of the rectangular wings distorts. It's not simple, not like a water ripple. A tiny iteration of the rectangle has popped out of it. He thinks about the logo splitting.

Damien spends a long time wrinkling and folding the mesh. He puts the butterfly on the fold of his elbow and watches it change as he moves.

No one calls him down to dinner. Grandpa makes pork and beans, and no one saves Damien a portion. He eats a scone and makes more coffee and stays up all night, working on his butterfly. The way 3D images fold is different from flat images, and it fascinates him. The motion of the skin becomes a part of the art.

Sometime around two in the morning, not knowing why, he adds a curl of barbed wire under the butterfly. Low and shallow, it is harder to break with folding. It holds its form as wings tessellate and compress over it.

Damien shows them the logo first, then the butterfly. He doesn't wrinkle the mesh—he doesn't want to have to explain it. Without any wrinkles the lines on the wings appear random, but it is still a passable butterfly, if not real and alive like the one Aubery drew.

Dad chews the inside of his cheek. "Dad'll never agree to it," he says.

"I'll sell designs online, from my room. I just need my own data plan," Damien says. "Grandpa will never know."

Dad looks at Ray. Ray shakes his head. "There's just no money for it," Ray says.

"Why can't you do something," Damien asks his dad. "Why can't you get a job? Some kind of job?"

Dad's face gets red just like Grandpa's. Damien blacks out for a second after the punch to his jaw. Not long enough to fall. Dad stomps away.

"You shouldn't have said that to your own father," Ray says.

"Why don't you get a job?" he asks Ray.

"Why don't *you*?"

Damien doesn't answer that he has a job as Grandpa's assistant. Grandpa doesn't pay him because times are tough. He stands mutely while Uncle Ray storms off muttering, "Like jobs can just be *got*."

Damien smooths the Flexi-Print sample over his Adam's apple. He looks at himself in the dusty mirror. The clown lamp is behind him. He turns on the simulation. Aubery's face floats against his chin. He adjusts its size up as high as the small patch will allow. He moves the image in front of his face.

It won't expand further than the width of the patch. One third of Aubery covers his

face, like he and Aubery are spliced together. The nose isn't quite right.

He turns to the side and watches her slip into negative, like a wax casting.

He turns it off.

He thinks about sex on the bunk beds in the storeroom. Solidity. Solid objects. His fingers crushed between the headboard and wall. He thinks about his father and his uncle, on those same bunks as boys, also trying so hard not to be heard. That is his family—living on top of each other and trying not to touch.

Holograms can't bruise each other.

He opens his butterfly file. He deletes the barbed wire and watches the butterfly flex its wings a few times on his arm. He has figured out how to match it to the range of motion of his elbow. As he bends and straightens his arm, the butterfly twists and takes off, hovers and drops. He smiles.

Damien packs scones and beer into the lunch box Dad used to use when he had a job. He writes out the directions to the sales rep's address on old receipt paper. He leaves Aubery's diminutive face playing in the air over the kitchen table, a placeholder for the space he leaves behind. ■

The Philistine

Ted White

I destroyed another painting today.

I fed it into the big machine and waited while the machine hummed and sliced and diced it, extracting the entirety of its essence, and reducing it to a fine powdery ash. Another van Gogh, gone. Like so many others. Canvas, frame, all gone.

But not for good. Not really. With the push of a button another machine would produce a new replica, theoretically indistinguishable from the original—not that the original was still available for comparison, of course. The machine had created a digital file of “Still-Life with Straw Hat and Pipe” and as many copies as were wanted could then be made. In time, every major art museum that wanted one would have it.

Ironically, I’m an artist—the traditional kind who works in oils, although I’ve tried acrylics. And I’m hugely conflicted about what I’m doing. But I had no choice. I could not support myself and my wife as a gallery artist, and my wife was adamant that I take this job when it opened up.

Leaving the downtown D.C. building where I worked as a Smithsonian employee was always like running a gauntlet. There were

protesters out there every day, ready to scream imprecations at anyone entering or leaving, waving signs that ranged from professionally made to crude, misspelled placards.

“Philistine!” they shouted at me, day after day, since the day I started working there. Some almost struck me with their signs, which they brandished at me like threatening weapons.

“Just ignore them, Harry,” Betta would say. “They can’t hurt you. The police will see to that.” My wife has never gone through this experience. “Just pretend you don’t see them and walk right through, like they don’t exist.”

But I do see them. And then one day I saw someone I used to know. He caught my eye and it was too late to pretend I hadn’t seen him.

“Harry,” he said in greeting. “Been years.”

I shook his hand. “Robert,” I said. “How’ve you been?”

Robert Lightner was a fellow artist. We’d exhibited together several times. He glanced at the government ID hanging from my neck and said, “I didn’t know you worked here.” He didn’t have to say “you of all people.”

I nodded. “Want to get a drink down the street? Catch up some?”

Once we were settled on stools in the Oasis Bar & Grill, drinks in front of us, Robert asked, "Harry, what happened? I never expected to see you working there. I mean, you—you have a *tradition* in art."

He's referring to my Italian heritage. Three generations back, the family name was changed from Bellagio to Bell, a fact I once confided to him in another bar. My grandfather was a stone carver, but I think I'm the first known painter in the family.

"I'm not entirely comfortable with it," I admitted.

"Reducing great art to machine-made, mass-produced pieces—" Robert said.

"Making great art accessible to the whole world—" I responded, and for a few minutes, we recited cant back and forth. We both knew all the arguments, and to give Robert his due, he was no more welded to his side of the argument than I was to mine.

"Have you ever seen one of those things produced?" he asked.

"I have. We have a duplicator, an art printer in the room next to where I work." I suppose the art printers had their earliest origins in color printers—those devices which some used to reproduce currency, if not great art. But I think their real genesis was in the 3-D printers, which could create three-dimensional objects by building up very thin layers. Art printers, which we call duplicators, take it a step further, reassembling a painting from molecular components, producing a painted canvas on a frame that looks as real as the original—even to the wooden frame over which the canvas has been tautly stretched. "When they come out, there's this odor of turpentine. Every time I smell it I know they've printed something."

Of course I told him what I did. He'd already guessed. "I don't just feed in paintings," I said. "Prints, drawings, anything, really. I've fed in small statuary—I've got a size limit, but you could feed an adult body through that machine. Maybe not an obese one. . . ." We both chuckled.

"If you wanted to get rid of a body . . ." Robert mused.

"You'd have a digital file of what you'd done. Someone could recreate the corpse, and there you'd be again. And those digital files can't be tampered with. There are software protocols to

prevent that, due to the nature of the artworks that have been destroyed to create them."

"Have they ever experimented with, you know, mice or anything?"

"I don't know," I said. "But probably, because really it's a duplicator. You can duplicate anything, but I don't think they'd come out alive. Anyway, it doesn't have to be art."

"So why is it art?"

"Money. It costs a lot to create a duplicate. The machines themselves cost millions. Then it takes a ton of energy at both ends, just to start with, and of course there's the raw materials used, which already have a lot more energy invested in the state they're in to make them usable. Very little direct labor cost, the machines are automatic, once started. But still—a hypothetical example. Say I put a gold bar through—"

"Does it get destroyed, or can you use the same gold in the reconstitution?"

"It's destroyed. What's left is no longer gold. But real gold has to be used to build the duplicate—along with all that energy. The result is that the duplicate costs five or six times what the original bar was worth. So," I grinned, "no gold bars are replicated. But great art—it's priceless. And if you could have a hundred duplicates of van Gogh's 'Still-Life with Straw Hat and Pipe'—that's what I did today—at some thousands a pop, well, most museums find that very affordable, even with the 100 percent markup to help pay for the program."

Robert nodded and sighed and was about to respond when the bar's door opened, and the decibel level went up 50 percent as a dozen men and women carrying protest signs swarmed in and saw us. They recognized Robert. And I hadn't taken off my ID badge. That was a mistake on my part.

I grew up in Brooklyn, a street kid until I went to Pratt, and normally I like to think I handle myself well in bar brawls, but I'd had just enough drinking with Robert to lose my edge. That, and it's been more than twenty years since I last got into a physical fight.

So when I was surrounded by those demonstrators, I was slow to react. I didn't immediately swing around and put my back to the bar. That was mistake number two.

And I guess expecting Robert to be on my side was my third mistake.

But ultimately my biggest mistake had been not to realize that, due to its proximity, this bar

was the demonstrators' regular hangout, where they were known and liked—and either agreed with or sympathized with.

This came home to me when—my back finally to the bar, people thrusting their signs and screaming abuse at me, Robert no longer close by—the bartender tapped me on my head with a from-behind-the-bar sap.

I didn't pass out, but my legs turned to rubber, my vision blurred, and I slid down to the floor, one leg tucked under me, the other sticking straight out. An overweight woman tripped on my outstretched leg and angrily stamped on it. An unshaven man leaned down to yell at me that I wasn't getting away from them this easily and punched me in my left ear. I ended up curling into a ball while some of them kicked me or whacked me with their signs.

When it was over, I saw several tattered signs abandoned on the floor. I staggered to my feet, and the husky young bartender told me I'd have to pay for cleaning up the mess. I told him I ought to have him arrested, and made my way out.

"What's wrong with you?" Betta said when I got home. "Are you drunk? You look a mess! Disgusting!"

"I got beaten up," I said through puffy lips. "Because of the job. I don't think I can take it."

"What are you talking about? You have *responsibilities*. You can't quit. The way things are, where would you find another job? You're lucky to have this one!"

"I could go back to painting."

"No," she said emphatically. "I won't have that. You're too old for the starving artist bit. That's for young, *single* men."

Less than a week later, I was contacted by a man who asked to meet with me, and we arranged to get together in a downtown restaurant for lunch.

Of course I was suspicious. But I was surprised when I was met by two men, and the second was Robert Lightner.

I did not greet him with enthusiasm, and I avoided his proffered hand.

"What is this," I asked him, "another setup?"

"Harry," he said, "this is John Borgmann."

"I know that," I said, shaking Borgmann's hand briefly. "We've spoken on the phone. But what are *you* doing here?" I scowled at him.

Borgmann was at least twenty years younger than either Robert or me and had a fresh-faced earnest look. He belied that by taking immediate control of the situation, ushering us all into the restaurant, where he had a reservation for us. We were in luck and got the one table by the front window in an almost private alcove formed by the front door vestibule. Borgmann and I sat facing each other, and, to my discomfort, Robert took the chair next to me, on my left, furthest from the window and blocking me in.

After we'd ordered, Borgmann leaned toward me and said, "I'm from Full Disclosure. Have you heard of us?"

"One of those groups devoted to making everything public? Government secrets, business trade secrets?"

"Essentially, yes. But we're not interested in most government secrets. We devote our energy to ferreting out the illegal activities of the major global corporations, of which there are too many."

"I've never worked for any corporation, major or minor," I said.

"Robert tells me you work on art duplication."

I turned to look at Robert. I realized I had him to thank—or blame—for this meeting. "I do," I said.

"What exactly do you yourself do?" Borgmann asked.

"I'm not comfortable with this conversation," I told him. "What's your agenda here?"

"Well, unlike Robert," he said, nodding at Robert with a brief smile, "I'm not a protester. I'm not opposed to art duplication. And I'm naturally curious. All I know is what anyone knows, which is not much." His voice grew softer, more earnest. "Please do me the favor of explaining a bit about what you do. I'm not asking for any secrets."

"Nothing I do is secret. Most of it is drudge-work. Before any piece of art is duplicated it has to be as clean and, um, perfect as possible. Paintings are removed from their decorative frames and then cleaned. You might call it restoration. I don't work alone. Several of us artisans work together. This is the most time-consuming part. It can take hours or it can take days. We are very careful, of course. When the piece is ready, I put it through the scanning machine. As you know, it destroys the original.

It breaks it down into its component molecules.”

“Have there been any cases where the original was destroyed and the duplication file was corrupted? No dupes possible?”

“No,” I said, wondering if this was the dirt Borgmann was digging for. “No corrupt files. You must understand that this isn’t some fly-by-night operation. It’s a government enterprise, as careful and as thorough as the Manhattan Project. Everything was tested over and over before an actual work of art—something of value—was destroyed for the first time. I’m sure there were failures in the early days, before I was hired. I think most of them were in the duplicating machines, though—not the digital files. I’ve heard talk from the engineers. But there’s incredible redundancy built in. If a file *was* corrupted, it wouldn’t matter. There are multiple files created for each artwork.”

“I wondered about that,” Borgmann said as our meals arrived. Mine was an odd variation on a BLT using fried pork belly for bacon.

I was swallowing a bite of my sandwich when there was the sound of gunshots immediately outside. I turned to look out the window as Robert grabbed at my arm and said, “Down, man!”

I shook him off, transfixed by the sight outside. A man had fallen on the sidewalk, just beyond the restaurant’s entrance awning. A uniformed MPD officer and two men in suits stood nearby. One of those two men was holding a gun. The way he was holding it, I was sure he’d been the shooter. The three were talking calmly. No one was arguing, and no one appeared to be in detention.

“My God,” Robert said. “Did you see that?”

“I did, no thanks to you,” I said.

“I didn’t know who was shooting! For all I knew, bullets could be coming right through that window. There were so many shots.”

I looked across the table at Borgmann. “John, do you know how many shots there were?”

“I counted nine or ten. Give or take one or two.” He gave me a wry smile. “I wasn’t trying to count them, but I have OCD and do it unconsciously. But I often forget as soon as I’ve done a count.”

We both looked back outside. Two marked Metropolitan Police cars were now at the curb,

lights flashing. And double-parked beyond them was an unmarked black car with lights flashing from inside its windows. More uniformed cops and more men in suits now stood around the fallen man. No one was assisting him.

“Is he dead?” Robert asked.

“With nine or ten bullets in him—give or take one or two—what do you think?” I failed to keep the sarcasm out of my voice.

He gave me a what’s-wrong-with-you look and said, looking past me, “Did you see, did the guy they shot, did he have a gun?” Then, “What’s he doing?”

One of the suits had noticed us staring out and was nodding at us to his companions. Three of them walked over to the window and positioned themselves directly in front of it, their backs to us, blocking our view.

“That’s not very smart,” Borgmann said. “All we have to do is—”

“All you gentlemen need to do is to pay your check and leave,” said another man in a suit standing at our table. “By the back door. Now.”

Robert was seated closest to him and took it on himself to remonstrate. He’d barely gotten his first syllable out when the suit interrupted him.

“I can have you taken in for interrogation,” he said. “It takes hours, most of it spent in an empty room, alone by yourself, because we’re very busy right now. I couldn’t guarantee your release in less than twenty-four hours. You prefer that?”

Robert shrank, his shoulders signaling his defeat.

I quickly picked up the second half of my sandwich as Borgmann said, “I’ll take care of it,” brandishing his mobile, and the suit ushered us to the cashier, who got flustered because we didn’t yet have a bill. But she knew something had happened out front and that we’d seen it.

In moments we were standing in an alleyway next to the restaurant’s dumpster.

I checked the time on my mobile and said, “I need to get back.”

“I’m glad we met, Harry,” Borgmann said. “I’d like to stay in touch.”

I shook his hand and ignored Robert’s and went back to work.

The next time I saw Borgmann, he was alone, waiting for me down the block from the

protesters when I got off work. He asked me if I'd join him for a drink. I agreed, as long as it wasn't at the Oasis.

He laughed. "I heard about that. I asked Robert why you were being so short with him and he gave me the story. For what it's worth, he's really sorry. He wasn't trying to set you up in there."

"He certainly made no effort to help me," I said, and hoped I didn't sound like I was whining. But I was glad Robert wasn't with us.

We walked several blocks in companionable silence to a smaller, quieter bar and took seats across from each other in a booth near the back. I wondered if we were both avoiding windows overlooking the street.

"You know," I said as I slid into my seat, "I checked the news and there was nothing about that shooting. Did you hear anything?"

He smiled. "Oddly enough, I did—at work. The plainclothes cop saw a man running down the street, so *naturally* he shot and killed him. Turns out, the man was running because he was late meeting his fiancée for lunch."

"Cops," I said. "What're you going to do? Don't run, obviously."

"You said something that interested me," Borgmann said, once we'd given our drink orders. Again he leaned toward me, as though creating a more intimate setting for our conversation. "You said when you created a file for a piece of art, you created many files."

"Well, I don't. The software does all that." I shrugged.

"Of course. But the files are created. Then what? How are they transmitted to the printing machines?"

"It's all done right there," I said. "A hard-wired network. Nothing leaves the building—except the duplicated art, of course. There are only four duplicators—printers—with only one in use at any time. The others are for backup. Like I told you, redundancy."

"Robert told me you're an artist," Borgmann said. "How do you feel, destroying all that art?"

"Conflicted, of course. I'm not sure my being an artist makes any difference. Look at all those protesters—demonstrators—whatever. How many of them are artists? It bothers me every time I feed a piece into that machine. It doesn't help that I've just spent time lovingly restoring it—investing something of *myself* in

it. But I tell myself I've just helped endow the world with that piece at its best. That helps."

Our drinks came. I sipped mine. Borgmann said, "I agree. I don't think that great art should be hidden away in private collections, hoarded by some very rich person."

"No," I said. "It shouldn't. It should be in public view, there to be seen. And duplication makes it that much more accessible. And something else duplication does—it keeps these pieces from aging, from being destroyed by fires or floods. As long as the file exists and a duplicator exists, the piece 'exists.'" I made air quotes with my fingers.

"Ah, those files," Borgmann mused after sipping his drink. "I'd love to liberate them."

"It's not like going after corporate secrets, is it?"

He shook his head.

"Besides," I said, "even if you had the files—copies of the files—what could you *do* with them? I mean, it's not like you have a duplicator."

"That wouldn't be an insurmountable problem. That machine was manufactured, and to government specs. By a contracting manufacturer, which will have those specs. Actually, the complete design will be locked up somewhere hackable." He was musing now, thinking aloud, almost as if I wasn't there. But then he looked up, and we locked eyes for a moment, and he smiled. "You see how my mind works."

"So if you had some files, you could use them?"

"Not right away, but in time, yes."

"What would you do with the duplicates?"

"Display them publicly, of course. But maybe not in stuffy art museums. Maybe where more people are, public places. And probably in areas—countries—where great art is less commonly seen."

"You know these won't come cheap. The duplicator will cost you big time and each duplicate will run up the tab. There's no way to get around that. This won't be free art for the masses. You can't make hundreds of dupes and broadcast them to the world—unless you can pay for it. And they don't get any cheaper, the more you make."

He grinned at me. "Money is not an issue for Full Disclosure. We are very well financed. I thought you knew that."

I shook my head. "I know very little about your group. Where do you fit in it?"

"We're not very hierarchical, but you could say I run it. At least here I do."

"So you don't have to clear anything with higher-ups?"

He shook his head. "No. What do you have in mind?"

"Something for each of us. Win-win. See, here's the thing. I think I could download some files—they're very big—onto a flash drive, some flash drives. That I could do." I gave him a sharp look and continued.

"But then what? Let's say you get your duplicator and you put it to use and you start making dupes. These things are going to attract attention. Sooner or later, but inevitably, the Smithsonian will find out. Unauthorized dupes of pieces they destroyed are turning up. How did that happen? They investigate. They narrow it down to me. I've violated the terms of my employment. What happens to me then?"

"We could easily hire you an attorney, Harry."

"Thanks. Someone to represent me while I sit in jail awaiting trial?"

"We could post your bail."

"I don't think you're getting it," I told Borgmann. "I have no appetite for being arrested and put on trial, win or lose."

"Okay. What *do* you have an appetite for?"

"Ideally? I'd like to get back to painting, to my own art."

He waited.

"In practical terms, that means I'd need the money to leave the country, relocate, and reestablish myself. Someplace where there's no extradition to the U.S. I'm sure that could be done for no more money than you'd just said you'd spend on me. The difference is, it would come directly to me—the artist. Support for the arts, huh?"

"So you want money."

"And you want the files."

He nodded. "I do. Let's talk numbers. How much would you need?" The haggling had begun.

I met with him a week later for another lunch in a different restaurant. Borgmann gave me a down payment on our agreed upon sum and a flash drive. It looked like a snow-globe, a kitschy paperweight. Unscrew the base to reveal the USB connector. He gave it to me in the

box the original globe had come in. It seemed unnecessarily bulky. It wouldn't fit in my pocket.

"Are you sure this is a good idea? Couldn't you come up with something less conspicuous?"

"Take it back with you. Display it on your desk." I didn't tell him I didn't have a real desk, just one I used when I needed it and shared with my coworkers. I felt no need. I accepted the box and the plastic shopping bag it had been in. The envelope with the money was in my jacket pocket. Throughout our lunch, I could feel its bulk between my left upper arm and my breast. I found it reassuring.

That night, Betta's after-dinner running commentary on my deficiencies was longer and more cutting than usual. I turned the sound off and stared at her with bemusement. How had I ever thought I loved her? Once, she'd admired my paintings. Now she belittled me for them.

She'd had a sizable inheritance and for a time was willing to use it to subsidize me. I sold some of my pieces, some of them for good sums, and I'd had a spate of good sales in the first months of our marriage, but they dropped off and ceased to be dependable income. I'd never had a regular income, in the best of times. Feast and then famine. This was not what Betta wanted. She threw acid on our relationship.

It was hard this evening to completely avoid hearing what she was saying, and gradually it dawned on me that she was leading up to something. Finally she delivered her punch line.

"I'm leaving you. I've discussed it with an attorney. You'd better keep your day job—your support payments will be hefty."

I think she intended that as a body blow, but I didn't flinch. Instead, I smiled at her and said, "That's fine. I've been wondering why we were still married."

"You'll have to move out, go to a hotel," she said. "Pack a suitcase." She stood up. "I'll call you a cab." She plucked her mobile from her purse.

I lived for nearly a month—four full weeks—in a residence hotel in Georgetown. I used the time to get everything ready. At the end of the fourth week, I called Borgmann,

and he came to my hotel room. He had an attaché case. I had the snow globe, once again in its box.

Borgmann took the globe out of the box and twisted off its base.

"I should tell you right now that you won't get much if you plug that into most computers," I told him as he looked at the USB connector. "All the code is proprietary, unique to the duplication project—another layer of protection, I guess. One of the reasons it took me so long; I had to get that thing reformatted."

He balanced the globe in the palm of his hand, its snowflakes swirling gently. "What are the other reasons?"

"Are you kidding? Just finding a time I could download a file wasn't easy. I had to fit it in, one here, one there. Some days I never had access. And I wasn't sure how many files it would hold. They're huge, you know."

"How many files *did* it hold?"

"Seven."

"Seven files? Seven paintings? We've paid you awfully well for just seven," he said, glancing at the case.

So I picked it up and opened it. It was filled with banded bundles of hundred-dollar bills. I rifled through several, digging down to the bottom layer, and all were real, and they weren't new and weren't in sequential serial number order. I counted the bundles, did a quick calculation, and decided it was good.

"You've got the best there," I said. "Da Vinci, Rembrandt, Picasso, top of the line. You've bought the best."

"Picasso?" He sounded dubious. "What period?"

"His best period, what did you think?" I laughed. "Not his blue period."

"Okay," Borgmann said. "Good. I heard your marriage broke up. Are you going to continue living here? I guess you'll be able to afford it."

"For now," I said. "Eventually I think I'll buy a house in the upper Northwest."

"Nice part of town," he said, carrying the globe, returned to its box, as he headed to the door. "Let's stay in touch," he said, and I closed the door behind him.

Of course, I had no intention of staying in touch. I knew it would take him and his crew a while to break the code. I'd paid a sizable chunk of Borgmann's down payment to an IT guy I knew. He'd loaded the megacapacity

flash drive with incredible garbage he'd created by literally scrambling code that he said he'd taken from a porn site. He didn't think anyone could unscramble it in less than a week, but I knew I couldn't wait that long. I checked out two hours later and left via the garage entrance. I found a cab a block away on M Street. It was Georgetown, after all.

There were good reasons why I hadn't gotten Borgmann the real files, the least of which was that I didn't trust him to do what he said with them.

The best reason was much simpler: I couldn't do it. I had no knowledge of the proprietary computer system. I didn't have the passwords. And a cursory covert examination didn't reveal any obvious USB connections anyway. This was no off-the-shelf consumer computer, after all.

I'd seen the man and his organization as heaven-sent, however. They had money and had given me some of it. Not a lot by their standards but a small fortune by mine. And it was good luck compounded when Betta finally decided she'd had enough of me. I'd planned to pull a disappearing act as soon as I became aware of Borgmann's interest in the art files, but she made it easier, kicking me out.

I left D.C. that night, a late flight out of National. A rather cheaply purchased fake driver's license got me through security and onto the plane. I took it to Atlanta, and from there, another flight to Los Angeles. There I bought a used car with a second fake driver's license and some cash, and drove east to Albuquerque, New Mexico.

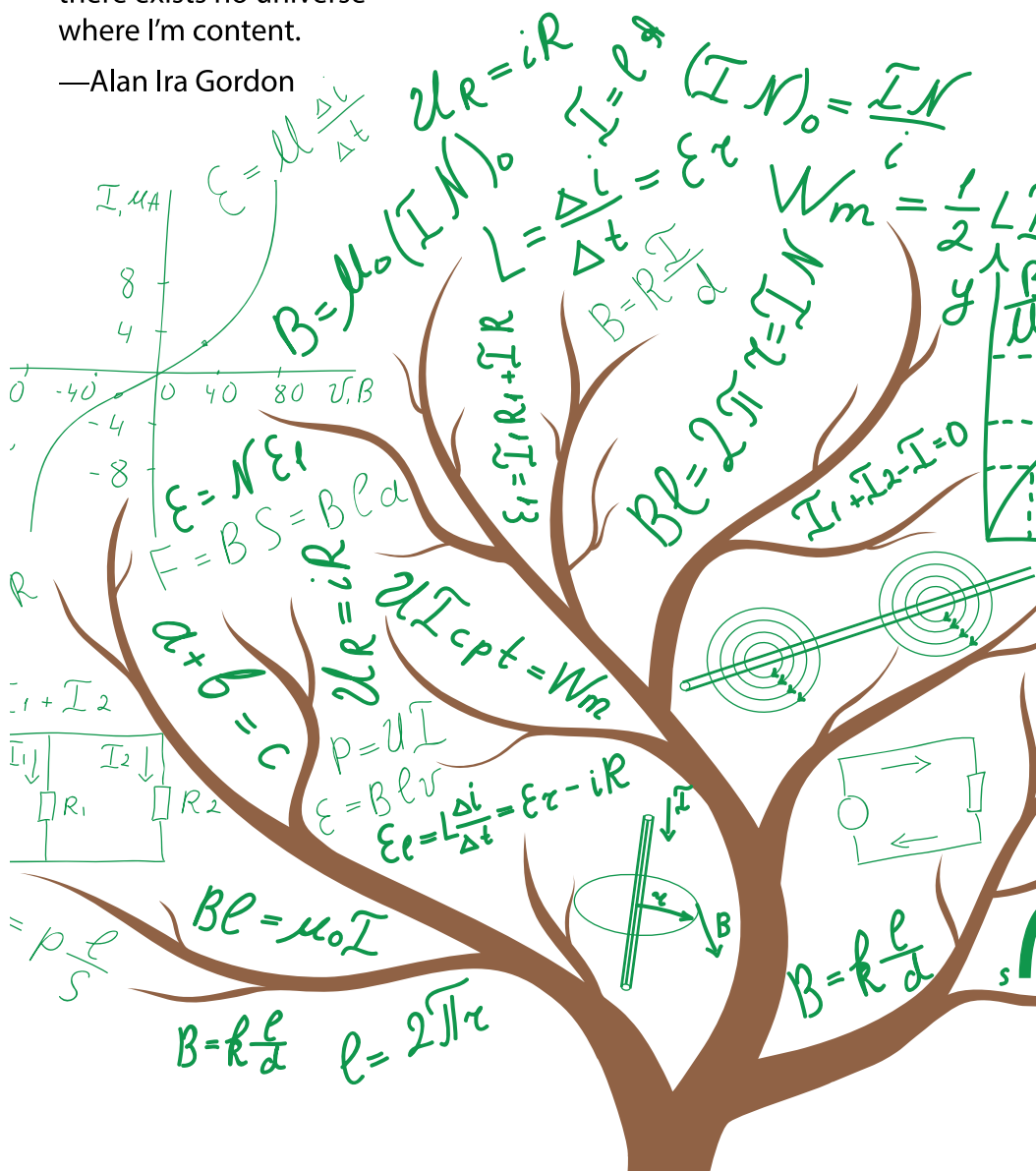
I've settled into an artsy little community outside Albuquerque, and I'm doing what I always wanted to do. I'm painting. It feels good. I've grown a full beard, which has transformed my appearance to a surprising degree. I'm living frugally, because even though I'm starting to get a few sales, I've got to make my "fortune" last as long as I can. And I've changed my style. I'm "regional" now, and I'm using a lot more bright primary colors—I used to think it was sophisticated, more subtle, to use subdued colors. I don't want to be recognized as Harry Bell, and I'm not revealing my new name here. But as an artist I'm thriving.

I regard John Borgmann and Full Disclosure as patrons of the arts. ■

How I Learned to Stop Worrying and Love the Heisenberg Uncertainty Principle

The multi-verses aren't infinite
my equations, they all proof-out
there exists no universe
where I'm content.

—Alan Ira Gordon



THE RETARDING OF SCIENCE

Last October I added a Google Analytics link to my online archive of these AV columns. Among other things, this allows me to conduct a “popularity contest” of my old columns. Rather to my surprise, the clear winner as the most popular of my 177 Alternate View columns so far is AV04, “*The Retarding of Science*,” published in the mid-December 1984 issue of *Analog*. That column was my only tongue-in-cheek foray into humor in writing these columns, but the surprising interest this 30-year-old column seems to have gathered encourages me to do it again.

The December 1984 column was inspired by a Leo Szilard short story, “The Mark Gable Foundation,” which described the creation of an endowed nonprofit foundation for the specific purpose of *slowing the pace of scientific progress*. In the story, a physicist emerged from cold-sleep two hundred years in the future to find that most of his scientific training was obsolete, and that science was progressing “altogether too fast as it is.” He enlisted the help of the world’s wealthiest man to create a nonprofit organization, the Mark Gable Foundation, dedicated to retarding scientific progress.

The Mark Gable Foundation achieved this objective by creating, for each major field of scientific investigation, a panel of distinguished scientists that would meet monthly to award prizes and grants for the best recent scientific work. (The Foundation, as Szilard pointed out, bears some resemblance to the U.S. National Science Foundation.) This plan, it was explained, would keep the best of the older scientists away from their laboratories and busy with unproductive travel, meetings, and report writing and would cause the younger scientists in need of funds to go for

the “sure thing” that would be certain to lead to publishable results, thereby filling the scientific journals with trivial results and channeling research in the direction of the safe, the fashionable, and the obvious, and away from the more risky innovations and breakthroughs at the frontiers of knowledge.

Inspired by this concept, in 1984 I announced the creation of the American Association for the Retardation of Science and Engineering (acronym: AARSE), dedicated to the retardation of scientific progress wherever it may occur, in whatever field, in whatever place. AARSE is created for the specific purpose of encouraging the retardation of scientific progress and of giving appropriate recognition to those who have done the most in the recent times to further this goal.

Not having a zillionaire backer like the physicist in Szilard’s story, I have had to change the rules slightly. I have made membership in AARSE free and open to all. AARSE members are self-electing. Anyone can elect to become a member of AARSE. To become an active AARSE member, one has only to make a copy of the Gold-Plated AARSE Certificate of Meritorious Effort reproduced following this column and present it to any and all who are worthy of recognition for their work toward the goals of the AARSE organization.

In the first incarnation of AARSE, the 1984 Gold-Plated AARSE Awards went to Senator William Proxmire, to the administrators of Columbia University and Catholic University, to the Institute for Creation Research of El Cajon, California, and to the State Legislatures of Arkansas and Louisiana. However, many other awards were presented privately by active AARSE members.

* * *

I had originally intended to present Gold-Plated AARSE Awards each year in my Alternate View Columns, but somehow writing columns about real science got in the way, and the 1984 Awards turned out to be a one-time thing. However, in view of the amazing online popularity of the old 1984 column, and the fact that this is the thirtieth anniversary of the creation of the American Association for the Retardation of Science and Engineering, I want to revive the tradition and present the 2015 Gold-Plated AARSE Awards.

The first 2015 Gold-Plated AARSE Award goes to Boston Patriots Coach Bill Belichick for the press conference in which he provided a “scientific explanation” of how 11 out of 12 Patriot footballs and zero out of 12 Colts footballs became deflated during their play-off game. Belichick set a new standard for “baffle ‘em with BS” in his pseudo-scientific explanation of the deflate-gate phenomenon, which should strongly promote the retardation of science. The “scientific experts” quoted by the media, and reaching a variety of conflicting conclusions, did not do much better and also deserve Gold-Plated AARSE Awards.

In view of the great number of botched explanations of the role of the ideal gas law in the Patriot’s kerfuffle, let me here attempt to present the real issues. The ideal gas law, $pV=nRT$, for a constant number of air molecules and small changes in absolute temperature (i.e., temperature relative to absolute zero), can be manipulated into the dimensionless form $\Delta T/T = \Delta p/p + \Delta v/v$, where $\Delta T/T$ is the fractional change in absolute temperature, $\Delta p/p$ is the fractional change in absolute pressure (i.e., pressure relative to vacuum), and $\Delta v/v$ is the fractional change in volume. *None of the media’s science experts mentioned or considered the volume term and its effects.*

If the footballs were inflated to a pressure of 13 psi in a 70° F room, and then taken to a 45° F field, the fractional change in absolute temperature is $\Delta T/T = 4.7\%$. If the gauge pressure drops from 13 psi to 11 psi, the change in absolute pressure is $\Delta p/p = 7.2\%$, so there is already a discrepancy.

However, a football does not have a constant volume when its internal pressure drops. For a 2-psi-out-of-13-psi drop in gauge

pressure, a completely rigid steel football would have no change in volume, while a “balloon-like” football with an elastic skin that responded linearly to gauge pressure would have a volume decrease of 15.4%. A real football that had been “rubbed down” by the professional ball handlers to make it more elastic should have a fractional change in volume somewhere between these limits, which I estimate to be around $\Delta v/v = 3\%$. (Enterprising readers of this column can get out their footballs and check my estimate experimentally, perhaps by using a variation the method of Archimedes.)

The net result is that Belichick was attempting to explain a 10.2% change in $\Delta p/p + \Delta v/v$ with a 4.7% change in $\Delta T/T$. His explanation was more than a factor of two off, and he also failed to explain why the Colt’s footballs did not show a similar pressure drop. Complete confusion in the science of footballs and gas dynamics resulted. It is therefore with profound emotion that I present Coach Bill Belichick with the first Gold-Plated AARSE Award of 2015.

The second 2015 Gold-Plated AARSE Award goes to the 56% of Congressional Republicans who deny the existence of climate change of human origin. This group has done an outstanding job of ignoring the views of the roughly 98% of climate scientists who have a consensus agreement that anthropogenic warming is real and serious, while quoting profusely from fringe sources and the 1–2% of climate scientists that have expressed other opinions. This is a brilliant application of a previously little-used technique that at a stroke confounds the distinction between science and uninformed opinion and brings scientific research into direct conflict with public ignorance in a way that has been sadly absent since the Flat-Earth consensus that existed before the voyages of Columbus and Magellan.

This group has recently increased its strength and effectiveness by assuming control of the U.S. Senate, and it includes the leading climate-change deniers Sen. Jim Inhofe (R-OK), new chair of the Senate Environment and Public Works Committee, Sen. Ted Cruz (R-TX) new chair of the Senate Appropriations Subcommittee on Science and

Space, Sen. Ron Johnson (R-WI) new chair of the Homeland Security and Governmental Reform Committee, and Sen. Mike Enzi (R-WY), new chair of the Senate Budget Committee. We of AARSE are confident that under this new and aggressive leadership, the retardation of science will be able to reach new levels of accomplishment.

The third 2015 Gold-Plated AARSE Award goes to the many anti-vax parents of children in the U.S.A. and U.K. who have wisely protected their children from autism by preventing their vaccinations for measles and other childhood diseases. They have bravely resisted the heavy handed prompting and requirements of government agencies and health authorities, who think that just because a link between vaccination and autism has been overwhelmingly rejected by a long series of scientific studies, all children should be vaccinated. These parents instead prefer to be “on the safe side” by accepting the validity of an autism-vaccination link originally suggested in 1998 in a paper by British gastroenterologist Andrew Wakefield. Wakefield’s publication has since been discredited and retracted by the publishing journal, and he has lost his medical license. These thoughtful parents cover a broad range of ideologies from Oklahoma redneck libertarians to California alternative medicine liberals, and they have done an outstanding job in confusing the distinction between medical science and uninformed opinion. It is clearly better to protect our children from the possibility of autism, even if it means that thousands of other children will be sickened or killed by a disease that we thought had been completely

eliminated from our shores. It is therefore with profound emotion that I present to all of the anti-vax parents their Gold-Plated AARSE Awards for 2015.

Due to the space restrictions of this column we are not able to give public recognition to the many other individuals and organizations who richly deserve to receive a Gold-Plated AARSE Award for their contributions and efforts. However, we are confident that the active members of our AARSE organization will be able to give recognition to most of these individuals on a personal basis in the coming year, by presenting them with copies of the 2015 Gold-Plated AARSE Certificate of Meritorious Effort provided below. And we expect a fruitful year of accomplishments in retarding science that will lead to a whole new set of Gold-Plated AARSE Award presentations in 2016.

SF Novels by John Cramer: My two hard SF novels, *Twistor* and *Einstein’s Bridge*, are newly released as eBooks by the Book View Café co-op and are available at: <http://bookviewcafe.com/bookstore/?s=Cramer>.

Alternate View Columns Online: Electronic reprints of over 177 “The Alternate View” columns by John G. Cramer, previously published in *Analogue*, are available online at: <http://www.npl.washington.edu/av>.

Reference:

Leo Szilard, “The Mark Gable Foundation” in *The Voice of the Dolphins and other stories*, Simon and Schuster, New York (1961). ■

The one sure way to conciliate a tiger is to allow oneself to be devoured.

—Konrad Adenauer

The 2015 Gold-Plated AARSE Certificate of Meritorious Effort

Whereas,

Science, Engineering, and Technology are progressing
altogether too rapidly as it is,

and

Whereas,

it is all a person can do to become accustomed to the
present technological changes without having even more
scientific progress to get used to,

and

Whereas,

it is high time that someone did something about it;

We of **AARSE**, the **American Association for the
Retardation of Science and Engineering** are proud to
present to:

the **2015 Gold-Plated AARSE Certificate of
Meritorious Effort**, in recognition of outstanding
achievements in the Retardation of Scientific and
Technical progress through ongoing and cumulative
efforts to delay, divert, discredit, obstruct, impede,
and/or interfere with the work of scientists and
engineers everywhere.

**Members of AARSE
January 31, 2015**

My Father's Crab

Bruce McAllister

"We're not alone in the universe. Even crabs know that. Watch them sometime. . . ."

—Jasper Cummings,
marine biologist, Scripps Institute
of Oceanography, 1962

I don't know where it was—that miniature golf course in the sand—but it had to be the Gulf of Mexico somewhere. We were driving from one coast to the other, like always. "The Great Southern Route," my dad called it. It had to be Florida, Mississippi, Louisiana, or Texas—one of them.

I was seven, and my dad had driven us across the U.S. and back half a dozen times by then. Looking back, I don't know why a young officer doing "top secret" work for the Navy was making that many cross-continental trips by car, but maybe it was what his constant reassignments demanded. Or maybe he just liked to be on the road, see relatives, get away from his desk whichever coast it was on. That changed as he moved up the ranks and was given more responsibility, but I remember what he was like back then, in the '50s, the Cold War, when he and I would play

miniature golf wherever we could on the way to the other coast. My mother and her mother—my grandmother, who lived with us—would watch TV in the motel rooms or go shopping for souvenirs in the beach towns. We were happy on those trips. My dad was the boy who'd left the Blue Ridge Mountains of Virginia to "see the world." I'd never see him quite that happy and alive until the end of his life, when he wasn't in the same world as the rest of us.

It was evening. That was half the fun. The golf course had a hundred lights strung on wires, and all were shining brightly so people could play as late as possible. You could hear the ocean somewhere, but the sand was close. You'd step in it if you didn't watch yourself. It was fun, the sand still warm from the day's sun on your bare feet while you'd tried to get the ball into the miniature castle or windmill. When you did, you got to listen to it spin around inside the little structure and make its way to the next hole—this one a loop-de-loop or tiny mansion or an alligator with an open mouth.

"Great job, Brad!" my father would shout, even if it weren't a great job (four attempts to

get the ball into a candy-cane house?). He said it the same way he'd say "Rise and shine!" or "Up and at 'em!" in the morning to wake me up. Corny lines, but I loved them. These trips were the only time I got to do much with him, and they mattered to him, too. I could tell.

When we were at home—and home changed every year or two—he'd leave for work in San Diego or San Francisco or Washington D.C. or Key West so early I'd have to get up at five if I wanted to have breakfast with him (Cheerios, of course) and listen to the radio together before he headed out. He'd return at 6:30 in his uniform, change into civilian clothes, and after dinner fall asleep in front of the television set watching Edward R. Murrow or *Perry Mason*. Watching him sleep, I'd get sleepy, too.

That evening, as we reached the farthest hole—where the ocean waves were loudest—he looked down at the sand and laughed.

"Well, would you look at that!"

I did and jumped. There were crabs everywhere, gray-green and walking sideways, and about as interested in the little buildings on the holes as they were in us. Where were they heading?

I had no idea.

"Where are they going, Dad?"

"Who knows?" He was staring at them the same way I was—I remember that—as if they were most remarkable things in the world. Which they were, the ocean breeze ruffling our hair and freezing time forever.

"Sometimes," he said, "crabs migrate. Sometimes they've got some place they're going, and they'll cross roads and fields and swamps to get there."

"Do you think that's why they're doing that?"

"No. I think they're here to play miniature golf."

At that, he grabbed me and swung me around laughing, and my club flew into the twilight.

When we'd retrieved it, I said, "Can we hit them like golf balls?"

"What?"

"Can we hit them like balls?"

He looked at me, then at the nearest side-stepping crabs, then at my golf club.

"I guess so."

I thought it would be cool. I wanted to see them fly through the air—crabs that could fly.

We hit a dozen. They didn't fly very well. They came apart, claws going one direction and carapace going another, and I could tell my dad's heart wasn't in it. He liked living things. I did, too, but I was a kid. I liked to experiment.

When we stopped swinging, he picked up one of the crabs we hadn't hit, holding it behind the shell where the claws couldn't get him. Then he carried it to a light and looked at it, watching the legs and claws flail trying to pinch him.

That was cool, too, I remember thinking—how you could hold them that way, and they couldn't get you. I was glad we hadn't killed any more than we did.

"Look at this thing, Brad. This is a different species than the ones in Key West."

I looked closely. He was right. It was the same color as some of the crabs in Key West. What made this one so strange was its shell. It looked like plastic. All crab shells look like they've been made in molds, but they don't look like toys. This one did.

"Maybe it's not a crab," I said.

"Of course it's a crab, Brad. An *arthropod*, a crustacean. It's just a kind we haven't seen before. When we get to San Francisco, we'll see new kinds there, too."

My dad loved sea life. He didn't just want to float in ships on the seven seas, be a sailor sailing the world. He wanted to know what was living in those seas, miles and miles down, and what kinds of ships you could build to explore them. If he could have taken a bathyscaphe—which he almost got to do a few years later—to the bottom of the Marianas Trench, he would have. He was an engineer, an inventor, and a naturalist at heart, not a battleship captain or a warrior. I didn't know it, but the work he was doing then was about "special warfare": sonar for finding Russian submarines, jammers to stop them from firing missiles, microwave communications before anyone really knew what "microwave" was, and the beginning of GPS. As a lieutenant in Undersea Research, he was interested in what would help our country defend itself, sure, but he was also interested in how marvelous it all was—the sea, everything in it, creatures and the human beings visiting it.

I loved my father if for no other reason than that he loved living things. I know that now. “You’re a living thing, too, Brad,” he told me one day. “Don’t you ever forget that. A wonderful living thing.” So I knew he loved me, too.

“But it looks like plastic,” I said.

“Yes, it does. But it’s moving, so it must be alive, right? Did you know there’s a crab where your mom was born, on the Big Island—a kind called *Carpilius*—that has spots on it like a cow; and another one—Big Island, too—that has pom-poms on its claws like a cheerleader? And dozens of kinds, big and small, that can pull their claws in to make boxes of themselves—so no one can get into them.”

“Really?”

“Yes!” His eyes were bright and wide, and my heart skipped a beat. What wonderful things to know.

“Does this one make a box?” I asked.

“I don’t think so. It’s long and thin, like a runner.”

The crab was still flailing, trying to pinch, but all I could do was stare at its shell. The surface was bumpy in a too-perfect way, and that made it look like a toy, too. And the color patterns, green on gray, weren’t very natural-looking either. They looked like a commando’s camouflage.

Before I could ask him about that, he jerked and nearly dropped the thing.

One of its claws had pinched him.

“That was stupid of me!”

He put the crab down on the sand, let go, and shook his hand—the one the claw had gotten.

“Now *that* hurts.”

He was looking at his hand. I was, too. There was a mark near his wrist, and for a moment I thought the skin was wiggling there, that something was in it and moving around. But then it wasn’t moving, and I looked up at my dad. He looked a little white, as if he might be feeling dizzy.

“You okay?”

“Sure. It just surprised me.”

He was lying, I could tell. He didn’t feel good, but what could I do? I was a kid.

Back at the motel, where I had my sleeping bag on the floor, and my grandmother had her

own room next to ours, Dad lay down on the bed.

“Shouldn’t you go to an emergency room?” my mother asked, her long hair beautiful as always. She was Hawaiian. A lot of Navy men had Hawaiian wives after the war. He’d met her in Pearl Harbor when his ship—his first cruise after the Academy—almost sank that famous day.

“It’s feeling better. If it’s worse tomorrow morning, I’ll go. Crabs don’t carry rabies and aren’t poisonous, so I’m sure I’m okay. . . .”

He was falling asleep, tired for some reason. As he lay there on his back, I walked quietly over to him and looked at his hand. The pinch mark, which looked more like a big spider bite, hadn’t gotten any worse. Again I thought I could see something wiggling under the skin near his wrist, but Dad didn’t seem to feel it, so I had to be wrong. Besides, skin didn’t wiggle like that.

The rest of the way to San Francisco, Dad scratched his hand but didn’t look white or dizzy anymore.

We stayed in a motel in Palo Alto for a week, looking for a house a lieutenant could afford, and finally moved in when the van arrived from Florida.

He was still itching. “You need to go see a doctor,” my mother insisted, her brown eyes flashing. “It could be infected.”

“Yes, infected,” my grandmother added. She would have wrapped his hand in herbs she’d dug up herself with an *o’o*—she’d been born in 1898 near Pahoia and knew traditional Hawaiian cures—but he wasn’t going to let her do that.

I wasn’t there for the meeting. School had started. But I heard them talking about it:

“The doctor thought I might have a splinter of crab shell in me, but he couldn’t find one even when he opened it up.”

“Does he want you to take medication for it?”

“Yes. Just in case.”

“Be sure to do that, John.”

“I will, Beatrice.”

My dad got better. He stayed better, and before long, we all forgot about the crab pinch. In three years he was a commander. We were living in San Diego, and he was executive officer of a Navy research laboratory—more

anti-submarine warfare research. It was a beautiful bay, San Diego, and I knew I wanted to be a marine biologist. It's what my father would have been if he hadn't joined the Navy, I told myself. We lived near the bay on the base, had a beach we could use, two little boats, and a tiny base grocery store—even a barbershop. Life was easy, and I could collect all of the ocean creatures I wanted.

One day after school, I came home and found my father lying in bed in their bedroom.

He looked white.

"What's wrong, Dad?" I asked. Mom wasn't back from the high school where she taught, and Grandma never came up to the second floor since her bedroom was downstairs.

"Sometimes, Brad," he answered, scratching his wrist, "I think I got a bug of some kind that day. Do you remember?"

"Yes."

"You can get a bug, and it'll last for years, coming and going and coming and going."

"Do you feel sick?"

"Just a little. Once every couple of months."

"I'm sorry."

"Nothing to worry about."

Why, a voice whispered to me, did it choose him?

Back then I didn't even know what the question meant. It was a whisper, an idea I could barely see.

He went to see a Navy doctor. My mom was pushing for an answer, and the doctor did blood tests, probed more, took more x-rays.

Some things don't show up on x-rays, I remembered thinking. I was in middle school now.

Again, they found nothing. He felt better in a couple of days, and we went back to living our lives.

One Sunday, when he was napping, I went to their bedroom and watched him for a long time. I don't know why. I watched him breathe, worried about him even though he hadn't said he felt sick. I was afraid he was going to stop breathing. That was silly, and I knew it. I wasn't five or six anymore, with fears like that. I was thirteen and knew better.

He twitched once or twice. I moved in closer, putting my face down next to his arm, and

for the first time in years could see it. I could see the skin move again.

I jerked back in surprise, my chair moved, and my dad woke up.

"What's going on, Brad?" he asked.

"Nothing. Just wanted to see how you were doing."

He looked at me strangely, we talked for a while, and then I let him get back to his nap. If he didn't catch up on his sleep on the weekends, he couldn't do his "top secret" work well for the Navy, could he? He might get sick, too. Sleep was important, I knew.

Three years later he was the executive officer of a NATO antisubmarine warfare research center in Italy (a big step up from San Diego), and we were all living in a fishing village not far from that center. We'd be there for two years, the Navy said. My mother and grandmother loved it, the green hills and the beautiful Ligurian Sea, but I didn't know what to think. I'd left my friends behind and didn't know if I'd make new ones.

I'd forgotten about Dad's "illness" because he never talked about it, it didn't show, and I thought it had disappeared a long time ago. I'd asked him once, back in San Diego, and he'd said, "Think of it like malaria. It won't kill you, but you feel lousy sometimes."

I could've gone to a base school in the Navy port of Livorno to the south, but Dad wanted me to learn the language and stay closer. With a tutor helping the first summer we were there, I pulled it off, and the more Italian I learned, and the more days I attended school, the more friends I made. Even two girls—one part German, with braids; the other dark with the biggest eyes I'd ever seen.

Dad liked to take me on Saturdays to fish in the village's little cove. The fish were tiny, but very colorful, and the place was like a pretty postcard. We could swim with masks, check out the fish and other creatures, talk about them all, and get back late with no complaints from Mom. She knew it made us both happy.

We didn't have TV—or at least didn't watch it much—but I knew from the adults and the American kids who went to school in Livorno, where we bought our groceries, that the Russians were about to do something. It was in the news. Everyone was scared. My dad and I

hadn't really talked about it, but I knew it was on his mind. It would have to be. Besides, he had a newspaper with him that day in the little boat and kept looking at it while our lines sat in the water, bobbars not bobbing.

He was reading an article and then suddenly stopped. He stared at the page—no, past it—and cocked his head, as if hearing someone talking. He wasn't blinking. Then he was blinking again, as if he'd come awake.

"Jesus!" he cried and sat bolt upright. The little boat rocked. Fear raced through my chest, but it wasn't about capsizing. I didn't know what it was about. "Why didn't NAVSIC tell us?" Dad was saying.

I had no idea what he meant—it was a Navy acronym, but I'd never heard it before. His eyes were wide open.

And then he stared into space again, was quiet for a long time—long enough that I got scared again—and suddenly began talking. But it wasn't to me.

I didn't understand what he was saying. It was English, sure, not another language, but every other word was technical. He was talking as if someone who could understand it were there in the boat with us, wanting to know, and it was time for him to report.

He was white as a sheet, but he didn't sound scared. He was just white.

He had a short-sleeve shirt on. Something moved in his arm near the wrist. I could see it. Anyone could have. It was moving to the words he was speaking. He talked, and whatever was in his skin listened. That's how it felt, though I had no idea what this meant.

I was scared, sure. The world was a scary enough place—with the Russians putting down a revolution in Hungary, launching a satellite, and frightening everyone with the kind of submarine my dad was trying to defend us against—and now this. This wasn't a "bug" you got from a crab, I told myself. This was something else. I wasn't dumb, and I wasn't a kid anymore. I thought of the movies people were seeing—*Invasion of the Body Snatchers*, *It Came from Outer Space*, and all the others. Movies my mother hated but my dad loved to see with me. I wondered again whether a crab could be something other than a crab, whether there were things in the Universe that could think and watch us even if they weren't like us.

And then it was over. My dad relaxed, color returned to his cheeks, and he said, "Let's go in. I need to contact a couple of people at the center. There's something they need to know."

Without explaining why, I let my mom know Dad needed to have his arm checked again. She pressed, but I that's all I would say: "He needs to have it checked, Mom." The doctors—even a team on the base at Livorno—still couldn't find a thing. They didn't know you could make incredible things out of plastic. And the thing the crab had put in my dad when I was seven moved in his skin only when it was told to, when something in our world was important enough—scary enough—to have it wake and listen and transmit . . . so that those who'd made it could do what they needed to do.

I didn't think these things all at once. They came in fragments, whispers, and it wasn't until I was a man myself that I saw them all in a single picture—a lifetime to make a picture.

Someone had been watching and listening and wanted to make sure we didn't destroy the seas. Not the land. The seas.

When my dad was eighty, he got dementia. Alzheimer's. It ran in his family. Dementia is common enough in the world, especially after a certain age, but his was different.

With each passing year of dementia he lived more and more in the sea, with the creatures that lived there, with the wonders of it—both in our seas and others. His doctors had never seen anything like it. He was so happy, they said. Alzheimer's so often has its darkness. His didn't. Sometimes he was a whale, sometimes a seal, sometimes something he just couldn't describe. Sometimes he lived for weeks in a submersible at the darkest, deepest depths of the sea where fish had their light and worms that were usually a few inches long in our world were the size of ships. His eyes were always wide when he described these things, as if he were already in heaven and could spend his days reporting how beautiful it all was and always would be even if he weren't there yet.

Sometimes, he said, he was an immense crab-like thing in a purple sea, happy to be there but knowing that creatures in distant seas by distant stars needed to be cared for, too; that machines—ships that didn't travel on

water—needed to be built to reach them, so that what needed to be done could be done.

Sometimes (he said) he was a mechanical thing, tiny, one of thousands crawling across the sands of another world, or flying through its skies, or scampering across its fields, waiting for an alien creature to pick him up, to present skin and flesh so that the device could be delivered, so that it could begin to tell what it needed to tell to keep that world from dying in the terrible fires the creature and its brothers were about to make.

Sometimes, he once told my mother and me, he was the purple sea itself, alive and aware, wanting only the joy and wonder of living things to last.

Were they grateful to him? I'm sure they were. All of this—these dreams, his heaven and happiness, not fear and worry—is what you give someone when he's worked for you his whole life even if he never knew it.

I did become one—a marine biologist—and as the years pass I'm still waiting for my crab. ■

IN TIMES TO COME

Next month, we learn that dangerous things can come in very small and numerous packages, in our lead story, "The Season of Ants in a Timeless Land," by Frank Wu.

- Psychic powers have long been a common genre trope, even with a lack of scientific evidence for them . . . but maybe *technological* telepathy isn't quite so unlikely. Find out in our featured fact article, "Brain Hacking," by Richard A. Lovett.

- And if uploading our minds to a machine were to turn out to be more complicated than we expect, how would we really know? Lettie Prell's "Baby Steps" raises the question.

- We all understand stories have value, but truly grasping just how *much* value might be one man's only chance to save his own life in "The Story of Daro and Arbolita," by Shane Halbach.

- Sometimes you have to risk *everything* to know if you're really risking *anything*, as in Ken Brady's "Building, Antenna, Span, and Earth."

- It's easy to say we should think of the greater good, but who gets to decide just what the greater good is? Adam-Troy Castro's "Evangelist" poses some uncomfortable questions.

- Then we see the final days of an alien prison in Timons Esaias's "Exit Interview," the conclusion of Stanley Schmidt's serial, *Night Ride and Sunrise*, and all our dependably excellent columns.

See you next issue!

All contents subject to change



Illustrated by Tomislav Tikulin

Night Ride and Sunrise

Part III of IV

Stanley Schmidt

By the late 22nd Century, human civilization had filled much of the Solar System—and begun to stagnate. Terror wars and nanotechnology research had led to crowding and tight security; populations were dense but not allowed to grow. Nanotech made life unprecedentedly easy, reducing the motiva-

tion for continuing exploration of Solssystem, and after decades of unsuccessful SETI, most humans assumed they were alone in the universe. People who earlier would have explored new frontiers were reduced to studying the work of those who did that before them.

Phil Bertram, an academic scientist born on Luna, found unread data from unmanned interstellar probes sent out in the previous century. One of them had apparently gone through an artificial spacewarp (the Gate) that brought it out into normal space far beyond where it should have been, and found a startlingly Earthlike but uninhabited planet.

Tantalized by the possibility of a real frontier, Phil and **Hazel Castagna**, a literary academic on Earth, hatched a scheme to establish a colony there with a few selected friends and colleagues. The key was another forgotten 21st-century discovery: a “mole drive” that could get them to the Gate and beyond in a reasonable time. While working to turn the dream into reality, Phil moved to Earth and grew personally and professionally close to Hazel. Eventually, they made the leap, a one-way trip, hoping to build a secret colony with a whole world to explore and shape as they wanted.

Initially it was easy and exhilarating. The technology they took with them made establishing a base and dealing with the new environment easier than any such effort in human history. Newtown, in a Mediterranean-like setting in the southern hemisphere, prospered and grew; Hazel and Phil drifted toward a long life together.

But their colony was not as secret as they hoped. Soon an uninvited Second Wave of colonists came through the Gate and moved into Newtown. Phil felt that Hazel must have told them about the Gate and the mole drive, and his feeling of betrayal led to their falling out.

Like the original colonists, the Second Wavers craved something they couldn't have in Solsystem, but not the same something. A motley assortment of people who felt oppressed by the reproductive laws on Earth, they saw New Horizons as a place where humans could again “Be fruitful and multiply.” They did so with a vengeance, using technological aids to achieve an unprecedented growth rate. Soon the Gate quit working, but by then, “The Fruitful” were well established in Newtown.

Twenty years after they arrived, the original colonists, outnumbered 15:1, felt that their dream had been hijacked. Most of

them, led by Hazel and a few misfit Second Wavers, established a new colony, Breakaway, on Zo, a continent in the northern hemisphere. Phil, hoping to fix the problem in Newtown, stayed behind, but got little for his trouble but frustration and bitterness.

A year after most of his friends and colleagues left, Phil is surprised by a visit from Hazel. She asks him to come to Breakaway to help with a mysterious problem that is threatening the new colony. Half-convinced that she wasn't responsible for telling the Fruitful about the Gate and the new world, he agrees to take a look.

He is introduced to Breakaway and its setting by Hazel and **Luk Zakowitz**, a young man born into the Fruitful but not comfortable with them. He joined the Breakaway group to get away from social pressures at home and for the adventure of exploring and developing a new frontier. A talented amateur scientist and tinkerer, he has established windmills as a major energy source to make the colony less dependent on imported technology.

Phil begins to feel for the new colony some of the enthusiasm he originally felt for the old, but everyone seems reluctant to talk about the problem they hope he can solve—and everyone is afraid to go out at night. Finally Phil gets Luk to show him the problem: Some of his windmills have been damaged at night, and nobody has been able to determine how. Lately the damage has spread to houses, and two people have died mysteriously while trying to investigate. The frightening events and elusive causes have seriously undermined morale.

Phil's attempts at indirect investigation fail, so he resorts to direct observation, patrolling the village alone at night, carrying a flashlight and a wireless stun gun (dazer) but trying to avoid using either. He does see a house being damaged, apparently by tiny organisms or machines disrupting it and the surrounding soil. When he tries to get a closer look, he is seized by unseen beings, losing his nightglasses in the process, and hauled off on a harrowing ride through the forest.

After passing through a narrow canyon, the vehicle emerges into a rugged valley that

has been carved into a hidden city. His captors, large “otters,” take him into a subterranean hall and give him a show, in which both otters and comparably large “bats” participate. They show him a working model of one of Breakaway’s windmills, with both bats and small flying creatures flying into the blades and dying—and then they destroy the windmill and look expectantly at Phil. His understanding is that the windmills are killing bats and disrupting their food supply, and the otters want the windmills destroyed—or they’ll do it themselves.

Phil tries to tell them that he’ll talk to the humans about it, and then tries to escape. He gets almost out of the canyon, but injures an otter in the process.

He calls Breakaway for help, and Hazel and Luk pick him up in a minicopter. They call an urgent town meeting to discuss their options. Leaving the planet is impossible; leaving the continent would only postpone a problem that must be confronted sooner or later. Factions quickly form, some (led by **Rod Corcovan**) calling for a preemptive attack to wipe out the otters and bats as future threats to human survival, and others for shutdown of the windmills as a goodwill gesture.

Both extremes are rejected. The colonists decide to leave the windmills running while waiting watchfully—and to get a linguist to try to communicate with the natives. But the only linguist they know is **Calantha McQuade**, a former missionary and zealous follower of the Fruitful in Newtown. Lacking a more palatable alternative, Luk calls her with an urgent request for help.

Calantha is intrigued but skeptical, and asks **Magnus**, the charismatic cult leader of the Fruitful, for permission to go, which he grants reluctantly. They’re both shaken by the alleged discovery of an alien intelligence on the world seen as a divine gift for the Fruitful to fill. She goes to Breakaway in one of Newtown’s VTOL craft, promising to keep Magnus informed of her findings.

Meanwhile, Breakaway must get through a night of apprehensive waiting. No more damage occurs, but the bats put on a “show of force” during which moderate colonists must keep Corcovan’s “exterminationists” from further destabilizing the situation.

Calantha receives a cool reception in Breakaway, but she and Phil plan a strategy for initiating contact. She’d rather do it alone, but Phil insists on going with her.

Borrowing a trick from the otters and bats, they drop a model into the native town to suggest that they’d like to meet—made in part by **Srella Lindholm-Mubindi**, ten-year-old daughter of one of the Breakaway residents killed in a suspected native attack. The model is soon noticed, and two residents of “Ottertown,” whom Phil and Calantha call **Sylvie** and **Goldie**, study it—while Calantha, with powerful tools for pattern recognition and analysis, begins to learn their language and program a translator.

Sylvie and Goldie soon get the hint and dialog begins, awkwardly at first but accelerating as humans, otters, and translator improve. The otters make explicit their demand that the windmills be stopped as dangerous, but humans need them. The otters are willing to discuss a compromise, but insist that the windmills be shut down while they talk. Luk does this, over strong objection from Corcovan and his followers. And when Calantha reports back to Magnus, he hints that he might favor exterminating the natives, which Calantha finds disturbing.

The humans get a look inside Ottertown when Sylvie tells Phil he must visit the otter he injured during his earlier escape. That is **Daredevil**, who earlier advocated destroying the human colony but is now willing to consider compromise—if humans and otters visit and try to understand each other.

Hazel begins going along on tours of the native city, and the humans are impressed by what they learn of otter society, including its use of marine agriculture, metallurgy, and phytotechnology. There are also mystifying gaps, such as the almost complete absence of the bats so evident on Phil’s first visit. Phil and Hazel enlist biologist **Dick Sysler** to help them understand native society, adding him to the group that shows Sylvie and Goldie around on their first nighttime visit to Breakaway.

They don’t see much during that visit, since humans are diurnal, and realize they’ll have to come back during the day, despite their fear of bright light. They accept

the addition of Dick to the next party visiting Ottertown. During that visit, the humans learn that the otters have both boats and steam engines, though they have apparently not combined the two. Dick has more fundamental questions, like: Why haven't they seen any young? He thinks understanding the otters' reproduction is a key to understanding their society, but it's likely to be a touchy subject, and he is concerned about how to bring it up.

XX.

Aside from Hazel's well-taken point about the humans' need to catch up on sleep, there were two main issues in getting ready for the otters' daytime visit. One was logistical, the other psychological and managerial.

Hazel and Phil saw two options for getting the otters to Breakaway. Hazel could give them a ride in the copter, or they could drive themselves over in one of their wagons. The copter would be quick, easy, and not leave their vehicle exposed to human tampering while they toured the village. But it would show them more than some humans might want of how it worked, and it would probably be uncomfortable for them since it contained no seating suited to their bodies. (Not that they'd considered that when carrying humans in their wagons . . .)

So everybody agreed that Sylvie and Goldie should come in their own cart, which led to the second problem: how would humans react to the otters' presence in their midst, and what could be done to prevent any major troublemaking or counterproductive reactions? Hazel and Phil agreed that reactions would vary widely, and they couldn't anticipate them all. A logical place to start was to post a guard by the visitors' vehicle before they left it, and who that should be seemed obvious.

"Luk," Hazel and Phil said simultaneously when the question was raised. Not only did they trust him not to do anything stupid, but guarding the wagon would give him a good excuse to look it over and see what he could learn about its construction and workings.

Tension ran high in the village the morning of the visit. It seemed everyone was up at the

crack of dawn, not knowing exactly when the ambassadors would arrive but not wanting to miss it.

They arrived quite early, perhaps because they hoped to get this over with before they were too far from the perceived safety of darkness. Phil was still in his cottage when he heard a burst of chatter outside, slightly muted by the walls and the low setting on his audio pickup. "Here they come!" he heard someone call, and then he noticed the familiar sound of an otter wagon, though it was different here since it wasn't running on constructed road.

He scrambled to finish dressing and hurried out the door. A handful of people were gathered outside, all looking toward the wagon as it emerged from the woods a couple of hundred meters away. Its sound grew louder as it approached, and more Breakaway folk poured out of their houses. Hazel was among the first, quickly joining Phil, but Calantha was nowhere to be seen. "Somebody get Calantha!" Hazel yelled. "And tell her to bring her stuff."

As soon as the wagon halted near the edge of the cluster of houses, it was surrounded by people pressing in much too close, though most of them were obviously intimidated by the big draft animal in front of it. Phil wasn't sure who looked more apprehensive: them, the otters, or the dragonhorse. It was even harder than usual to tell, as both otters and horse wore very dark goggles. The townfolk were seriously crowding the visitors, moving around chaotically (some of the younger ones practically dancing) and all jabbering at once, louder and louder in their efforts to be heard.

Most of which were in vain, since Calantha's translator was not yet on the scene.

Hazel tried to restore some order. "All right, all right!" she barked from atop a convenient rock. "Give our visitors some room! You'll all get a chance to meet them and talk to them, but not all at once. Think how you'd feel if you'd just arrived in their town for the first time."

People tended to listen to Hazel, and that did the trick, for most of them. Corcovan and his friends, unsurprisingly, scowled and grumbled, but even they backed off when Hazel scurried around shooing everyone away from

the carriage. Otters and horse relaxed a little but still seemed nervous. Phil was relieved to see Calantha hurrying toward them, obviously not yet fully awake but with a newly compact version of her translator in hand.

"Sorry I'm late," she said breathlessly as she settled into the freshly vacated space around the visitors. "I didn't realize you'd be this early, but welcome." Phil couldn't tell whether her expression was really welcoming, but he was confident the otters couldn't either.

"We're glad to be here," said Sylvie. "We look forward to getting to know you."

The hubbub started up again, and the translator couldn't handle it all. Again Hazel intervened, throwing her hands up and saying, "All right, people! The translator can only handle one at a time. Here's what we're going to do. I'm going to introduce our visitors now—this is Sylvie and this is Goldie, and no, of course those aren't their real names, but they're what we call them and Calantha's translator handles the details. And now you're all going to go back to your usual posts and do what you usually do at this time of day, and we'll show our guests around. You can ask what you want when we get to you."

Conversation died off gradually as people dispersed. "I never imagined they'd be so noisy," Sylvie remarked when they were gone. "It was rather frightening."

"I'm sorry about that," said Hazel. "It certainly was different from the response when we visited you, wasn't it? But they weren't threatening you. Most of them don't want to hurt you, if we can work out a better way. They just get excited. It will be better when we just meet one or two at a time. Let's start here. This is Luk Zakowitz. He'll be watching your carriage and horse. He'd be interested in hearing about them. . . ."

Luk and Sylvie hit it off well. They were both gadeteers, and talking shop about things they'd worked on was apparently a great relief after the high-pressure crowd scene when the wagon arrived. But even that was not without its tense moments. "You built the windmills?" Sylvie said, rather sharply, it seemed to Phil. "That's . . . interesting. But they've done so much harm to—"

"We never intended that," Luk interrupted gently. "We didn't know you were here when

we made them. As you know, we've shut them down for now, while we try to figure things out."

"We appreciate that," said Sylvie. "But still—"

"I'd like to show you how they work," said Luk. "But for now I have to guard your vehicle while Phil and Hazel show you around. Maybe later?"

"Maybe," said Sylvie. "But why do you have to guard our vehicle?"

"Some of our people distrust you," Luk said with obvious discomfort. "They might . . . bother it."

"Oh," said Sylvie—but she neither looked nor sounded reassured.

The rest of the town was a mixed bag. Hazel and Phil took Sylvie and Goldie around, showing them everything from the interior of a couple of houses to the gathering hall to the farm plots where food was raised. Calantha accompanied them with her translator but took little part in the conversation. Everywhere they went, hosts introduced guests to whatever colonists were around. Most seemed glad enough to talk about what they were doing, though wary of saying too much. All were obviously curious about the otters but varied widely in their reactions. Some bent over backward trying to be polite, even though they had no idea what the otters might consider polite or rude. A few, like Corcovan, were sullen and closed-mouthed but stopped short of open hostility.

It was hard to read the otters, especially with their opaque masks, but Phil had the impression that they were at least surprised, if not puzzled, by much of what they saw—even things as basic as the fact that the humans lived singly or in small groups in separate above-ground houses. They stared intently at each human they met (which naturally made some of them uncomfortable), and Phil could only speculate about what they were contemplating with such intensity. Were they, for example, marveling at how much individual humans differed—or how much they were alike? He didn't know how easily they recognized individuals.

Some of the people they met were children, of course, and it increasingly seemed to Phil that Sylvie and Goldie stared at them with especially concentrated curiosity. He had no

idea why until something completely unexpected happened.

They had pretty much completed their rounds, undoubtedly leaving Sylvie and Goldie as tantalized and unsatisfied as the humans had been by their first glimpses of Ottertown. They were on their way back to Luk and the waiting wagon when they came around the corner of a house and found Srella Lindholm-Muhindi standing right in front of them.

Another child might have fled in shyness or fear, but Srella just stood there looking straight at Sylvie and Goldie. "Hi," she said in her little-girl voice. "May I ask you a question?"

The touring party stopped in its tracks, all startled for their own reasons. "Of course," Sylvie said after a moment's hesitation.

"My name is Srella. Did you like my model?"

For a long moment, no one answered. Then Sylvie asked, "What model?"

"The one Uncle Phil and Calantha showed you. I helped make it."

Again both otters were speechless. Finally Goldie said, "Yes, we liked it very much. It was very good."

"Thank you." Srella stood silent for a goodly while, as if she wanted to say something else but couldn't quite bring herself to do it. Finally she said, "It was nice meeting you. I hope we can all be friends." Then she turned and almost ran away.

When she was gone, Sylvie looked at Phil and Calantha, who happened to be standing next to each other, and asked, "These small individuals we have seen—they are new ones?"

"Yes," said Phil. "Though we say 'young' instead of 'new' when talking about people. We also call them 'children.'" That should help the translator be more colloquial the next time the subject came up.

"And this one who just spoke to us," said Sylvie. "Did she really help make the model you brought us?"

"Indeed she did," said Phil. "In a big way. She's remarkably good at such things, for one so young."

"I would agree," said Sylvie. She looked from Phil to Calantha and back again. "Did you two make her?"

"What?" Phil frowned, then understood. "Oh. You mean, is she our daughter—our child? No. We're not a couple." He found the

suggestion not only startling, but also vaguely embarrassing; and he saw Hazel giving him an odd look that he couldn't quite decipher. But he also found it exciting, because he recognized it as the opening Dick had been hoping for to start a discussion of reproduction and child-rearing in both humans and otters. Ironical that the humans had agonized so over how to bring it up, and an otter was the one who did it. "Srella's the daughter of . . . a friend," he said and bit his tongue before saying more. Now was not the time.

"How remarkable," Sylvie remarked, "that a child should play such an important role in your society." She seemed to hesitate. "It also surprises us to see so many children moving freely among the adults. Is it always so among you?"

"Often," said Phil. "Not always." Heart pounding, he added, "And how is it among you? We were just as surprised to see no children—or at least none that we could recognize as such—when we visited your home. But we feared the subject might be delicate, so we didn't ask."

"If we are to understand each other," said Sylvie, "we must ask such questions—and answer them. Such matters are basic to how we live. No doubt we will ask you more later. In the meantime, when you come to our home tonight, we will try to start answering yours."

The tour didn't last much longer, but Phil finished it in high spirits, feeling that a major milestone had been passed and looking forward eagerly to what they might learn tonight.

When Sylvie and Goldie were safely aboard their carriage and on their way back home, and all the other humans had dispersed, Hazel turned to Phil. "So they thought you and Calantha were an item, eh? What have you two been doing over there, anyway?"

"Just trying to get to know the natives," Phil said, blushing in spite of himself. "Remember they know little of humans. They can easily jump to wrong conclusions, just as we're undoubtedly doing all too often."

"Indeed," said Hazel. "Well, see you tonight, Phil."

She went off without further comment, leaving Phil to wonder why she cared what the otters thought about his relationship with Calantha. It sounded curiously like jealousy.

Could it be that she was hoping to revive the relationship he and she had once shared?

Watching her go, he thought that might not be so bad.

XXI.

On that night's visit to Ottertown, Sylvie and Goldie cut right to the chase. They used the same larger wagon, since Phil, Hazel, Calantha, and Dick had all come, but this time they went directly to a place unlike any they'd seen yet. Here, at a glance, Phil saw the answer to the question, "Where are the kids?"

They were here. Maybe not all, but at least a great many—several dozen at least.

It was a large room carved from the outer cliff face, with a big window overlooking the sea as in Daredevil's home—but here the window was covered with some sort of sturdy mesh. Broad steps led up to the sill, though, and miniature otters sporadically scampered up the steps to peer outside and tug at the screen, then scampered back down to do things with other objects—toys?—strewn about the room. The otters came in a wide range of sizes, from tiny to almost adult, with a correspondingly wide range of toys and activities. A few who were obviously adults wandered among them, apparently keeping an eye on the younger ones and occasionally stopping to help or otherwise converse with one, or to break up a squabble.

It reminded Phil immediately of Mrs. Cripps' Baby Farm, his neighbor back in Newtown, and he saw Calantha's face light up as if the analogy resonated with her, too.

"All babies are born," Sylvie was saying, "here in the city. They're brought to places like this to be cared for and taught our ways until they're old enough and know enough to take their places among adults. We call this a *crèche*." They obviously didn't, of course, but Calantha's translator was smart enough to offer that translation on the basis of Sylvie's description.

"Their parents don't care for them and teach them?" Hazel asked.

"No. Parents have other jobs. Crèches have people who do this as their job. Learn to be very good at it."

Uncharacteristically, Calantha jumped in. "I can understand that. My people have something like that in our city far away. It works."

"It works here, too," said Sylvie. She laid a hand briefly on Goldie's neck. "This one, for example. Goldie came from my body not far from this spot. Then raised in *crèche*, but we sometimes saw each other. Now we're very close, in both work and life. Not so, Goldie?"

"So," said Goldie, similarly ruffling Sylvie's neck fur.

Phil was still trying to process what he thought of this unexpected parallel between the otters and the Fruitful when something else caught his eye. Here and there among the little otters he saw even littler bats, in greater numbers than he'd ever seen bats here except on the night of his abduction.

At first he thought they were toys. Then he thought they were pets, when he saw that they were clearly animate and clearly interacting with the otter kids. Then a suspicion began to form, and he tried to think how to word his question. All he got out was, "Some of them have wings. . . ."

"Yes," Sylvie said before he finished. She made a sound that the translator ignored, then added, "Let me show you something—and I'd like you to meet somebody."

She and Goldie led the humans out of the playroom and around its outer wall through a passageway onto a sort of balcony, set back under an overhang and giving a clear view of the starlit sea, with waves crashing on rocks below. She let out a startlingly loud cry, also untranslated but repeated several times. Then she said, "Now we wait."

Several minutes went by, giving Phil plenty of time to wonder what they were waiting *for*. Finally he heard a new sound, vaguely similar to otter talk but reminding him even more of something else that he couldn't quite place at first but which sent a shiver up his spine.

Then, just as he remembered where he'd heard it before, he heard flapping wings, growing rapidly closer, a big shadow swept across the cliff next to him, and a full-sized bat landed on the balcony railing two feet from his side. Hazel, Calantha, and Dick all gasped, then regained their composure with a conscious effort. They'd never seen one this close before; it was appreciably smaller than Sylvie or Goldie, but still comparable to an eagle on Earth.

Sylvie said, "Folks, this is"—as usual, the translator arbitrarily picked a human-pro-nounceable name—"Bob." She paused as if for dramatic effect, then added, "My mate. Goldie's father."

She and Goldie stepped very close to Bob, and they exchanged nuzzles and caresses, he using the hands on his front limbs while briefly wrapping his wings (the middle limbs) around them, then folding them neatly out of the way. Phil struggled to get his mind around the idea that what he'd assumed were vaguely symbiotic species were actually two sexes of the same kind. It hardly seemed possible; he knew some animals on Earth had marked sexual dimorphism, but he'd never heard of anything like this.

How could it work?

Calantha's translator did at least as well as he did at adapting to new concepts. "Males and females," it said as Sylvie explained, "all start their lives here. They learn to be comfortable with each other, which will help them in later life. But let me finish introducing. Bob, these are the guests I mentioned to you: Phil, Calantha, Hazel, and Dick." She indicated each as she spoke whatever she used for their names. "They say they are from another world. Their kind built the windmills. We're trying to decide what to do about them."

Bob said something—a rather lengthy something—that sounded a little like otter talk, but now that Phil's ear had become somewhat attuned to that, he decided this was something quite different.

And the translator couldn't handle it. Calantha looked baffled and anxious, then said, "I'm honored to meet you, Bob, but I doubt you can understand my telling you so." She turned to Sylvie. "Forgive me if this question offends, Sylvie, but do males and females speak different languages?"

"Of course." Sylvie didn't seem at all offended. "As you can see, there are many differences between our bodies. We gather that you humans also have two sexes, but we marvel at how little they differ. We're not always sure which is which. With us, it's easy to tell, but that means we do many things very differently. Bob and I can't make the same kinds of sounds, but I can understand his and he can understand mine. It works, and seems the

natural way to us. The fact that you all speak the same language doesn't. So it took us a while to realize you had two sexes."

"Fascinating," said Calantha, in a stiff voice that suggested she was trying not to show her true feelings. "But it's going to make an extra challenge for us. We'll want to get to know Bob and others like him, but my translator doesn't know his speech yet. Can I get a chance—soon—to spend some time with him, to train it?"

"I hadn't thought of that," said Sylvie, "but of course. We can do that in a little while, but first I want to tell you a bit more about how things work. Bob, why don't you go mingle with the kids for a while and we'll let you know when Calantha's ready to chat with you?"

Bob said something not yet translatable, then disappeared down the passageway through which they had come from the nursery. "Females live their whole lives here, farming and making things. Males, like Bob, spend most of their nights traveling the countryside and their days in communal lodges out there. Their wings let them roam much faster and more widely than we can, which enables them to bring us things and knowledge that we can't get right here. We females provide a stable base for our culture and make many things both sexes need."

"But not food," said Calantha.

"No. Not food. Males and females eat different things." Out of the corner of his eye, Phil saw Calantha frowning again. "Though some of the things they bring us are substances that make food taste better or more interesting. We give them things that do the same for them." She gestured toward the path by which Bob had left. "Sometimes, when they come back to town, males come here to visit with the kids and show them what adult males are like. Females need to know because eventually they'll have to interact with them as adults themselves. Males need to know even more because eventually they will *be* adult males, and need examples to emulate.

"When they're a little older and have become stronger flyers, they learn even more about what's expected of them. They leave the crèche and go out, often with their fathers, to live in one of the male lodges and learn male things. Soon they're full members

of male society, and start doing useful male tasks and coming back here to carry things, visit, find mates of their own."

"Fascinating," said Calantha. "I can't wait to hear more about all this—from Bob."

"You don't have to wait," said Sylvie. "Let's go get Bob now."

She led them back through the short passageway and into the crèche. Bob crouched in the center of the room, wings partially but impressively unfurled, surrounded by little otters and bats, all apparently clamoring for his attention. Sylvie caught his eye and asked him to come over. It took him a couple of minutes to disengage from eager kids of both sexes, but then he came over to where he and Sylvie could talk privately.

Calantha's translator caught Sylvie's side of the conversation, but not Bob's. "Calantha would like some time alone with you. I've told you of her box that translates between our female speech and their human speech. . . . Yes, just one kind of human speech. Males and females speak same . . . Yes, I know it's odd, but their sexes are much more similar than ours. . . . She needs to talk with you. Let her machine listen and watch what you're doing while two of you talk, so machine can learn to interpret male speech as well. Okay? . . . Good. We'll drop you two off in a private room, and I'll find another for the rest of us."

It felt odd being alone in a room with Sylvie and Goldie but not Calantha or her translator. Sylvie and Goldie stayed, to keep an eye on them Phil supposed, but they probably wouldn't understand anything the humans said.

Or would they? Their whole society depended on both sexes being able to understand a language they couldn't speak. During their interactions with humans through Calantha's translator, had they learned to understand any human speech without it? "Sylvie," Phil said tentatively, "can you understand what I'm saying?" If she did, she gave no sign. "How about you, Goldie?"

Neither of them even seemed to be listening. Which might mean that they couldn't understand, or that they didn't want the humans to know that they could.

Phil shrugged. They'd have to proceed as if they actually had privacy, without knowing

whether they did. As he pondered where to begin, Dick took the initiative. "Well, we definitely need a new name for the whole lot of them. We can't keep calling them otters and bats if they're just two sexes of the same species."

"How about Zoey's?" Hazel suggested. "You know, from Zo."

"Yes, we get it," said Phil. "Sounds as good as anything. Let them be Zoey's. But how can sexes be so different?"

"Actually," said Dick, "I have some ideas about how that might have come to be. I think my subconscious was beginning to get an inkling even before I met them personally, and now I think it was on the right track. It's pure conjecture, of course, and I can't prove it's right. But I think it's plausible. Want to hear it?"

"Of course," Phil and Hazel said together.

"I think they diverged from an ancestral form that was amphibious and evolved to exploit the intertidal zone. As we're well aware, that has a lot more character here than in many places on Earth. It's rocky and extensively fractured and jumbled, and the planet's position relative to Sun and Selena is conducive to very high tides. It's a turbulent place, and creatures that live in it have to either adapt to deal with huge tidal changes, if they stay, or move back and forth, or up and down, to stay within the zone.

"I'd guess the Zoey's' ancestors took that approach. They not only learned to move with the tides to stay close to the water's edge, but ventured beyond it in both directions. The intertidal zone has one set of resources to offer, the ocean beyond the low tide line another, and the land beyond high tide still another. An organism that could exploit two of those would have a big evolutionary advantage. One that could exploit all three would have an even bigger one. That much could explain how the otters became top dogs, so to speak. They can, for example, eat things that grow both in the sea and on land. And by staying on land for a while, they can do things that would be very difficult in water, like make and control fire."

"Yes," said Hazel, "but what about the bats?"

"I mentioned three zones, but there's a fourth: the air. A creature that could live and

travel there would have another big advantage. If it could fly, it could venture much farther from the water, gathering information about what lay beyond and bringing back useful things it found out there. That's what the bats have done."

"I can see that," said Phil. "I've read about similar things happening on Earth. And I can see why it would be too much to expect for one form to thrive in all four zones. But when things as different as swimmers and flyers evolved on Earth, they were different species. Why the same one here? Why didn't the flyers evolve from something else entirely, that wouldn't remain so tied to the water?"

"Probably because the otters' ancestors were already so far along that they squelched anything else that threatened to evolve into a serious competitor. Let me anticipate your next question: How do you get such different forms from a common ancestor? It isn't really that hard. All the vertebrate analogs on this continent have six limbs. In the otters—excuse me, female Zoeyes—the hind pair have become flippers for swimming; the middle pair is multipurpose hands useful for swimming, walking, or grasping, but not optimized for any of those; and the front pair are high-quality, dexterous hands.

"Now, suppose you got an occasional mutation that caused the middle pair to take a step toward becoming wings. In a lot of species on Earth—including humans, I fear—such mutants would be outcasts and likely killed as abominations before they could reproduce. But the female Zoeyes seem to be less inclined than us to automatically view anything new as a threat. Obviously they recognize that possibility; their first reaction to our presence was to try to protect themselves and get us out of the picture. But it didn't take them long to move beyond that and try to learn about us and find a better way to deal with us."

"Not unanimously," Phil pointed out.

"Of course, but they got there impressively fast. I can easily imagine such folk, finding some of their offspring with new features and abilities, trying to find ways to exploit those instead of destroying them reflexively. It wouldn't take much for winglike structures to start hinting at their utility around here. There are plenty of cliffs they could glide off of, and New Horizons' thick atmosphere

makes gliding or flying relatively easy. That's how the bats—male Zoeyes—are able to be so big."

"Part of it, anyway," said Hazel. "A writer named Poul Anderson once invented a race of big, intelligent flyers with built-in 'superchargers' to make more efficient use of the air they took in. Do you think the bats have something like that?"

"They might, though with such a thick atmosphere they don't need them as much as they would on a less well endowed world. Anyway, big flyers are feasible here. They could evolve by mutations that change the structure of a set of limbs, and if that kind of mutation happens to be sex-linked, it could easily spread through one sex of a species like the Zoeyes."

"Would it even have to be sex-linked?" Phil asked. "Even if it weren't, couldn't the otters themselves select to steer each sex toward a different kind of specialization?"

"You mean by selective infanticide or something like that?" Dick smiled. "Yes, that could easily happen. Good suggestion, Phil. Anyway, however it happened—one of those or something we haven't thought of—it would give the Zoeyes, as a species, a huge advantage to have two sexes specializing in different environments. Females are at home here, on land and in the water; males on land and in the air. Naturally the sexes would develop separate cultures, with such different environments and ways of life, but they intersect here, where land, air, and water come together. And the intersection should be stable for quite a long time, because the sexes are about as interdependent as they can get."

He fell silent. Finally Hazel said, "Well, I don't have any better ideas. That's a fascinating picture of who they are, if it's anywhere close to the truth. We may never know, but at least it gives us some idea of what we may be up against. Now, I wonder how things are going with Calantha and Bob, and how do we get back together?"

XXII.

For Calantha, the night was very different. She felt apprehensive, settling into a room alone with Bob, knowing none of his language and not having Sylvie or Goldie to fall back on if failed attempts at communication raised

hackles. This was, after all, one of the beings who had attacked—or at least pretended to attack—human citizens of Breakaway on their own turf. He might even have had a part in killing a human or two.

He certainly *looked* fearsome enough.

But she plunged bravely ahead. The room they'd been given had an improvised stool for her and ledges and bars at various heights for him. And, she was pleased to note, an assortment of objects, a few of them even with recognizable functions, to manipulate and talk about.

The basic process was the same as with Sylvie and Goldie: They both did things, talked about them, and the translator looked for patterns and correlations. As patterns began to emerge, Calantha was more relieved than surprised to discover that though males and females had different vocal machinery, the underlying structures of their languages were similar, much as *Hamlet* in Pig Latin or Morse code is still *Hamlet*, in English despite the thin disguise. That made the learning process go much faster than it had with Sylvie and Goldie.

Not once did Bob try to attack or even threaten her. By dawn she was almost beginning to like him.

The first order of business back in Breakaway was sleep, but she only allowed herself a few hours. Then she spent an hour reviewing the translator's findings, and another hearing and discussing Dick's speculations about how "Zoey" society worked and how it had gotten that way.

Then it was time to call Magnus—and this time she made sure to double-check the time difference. "Big breakthrough," she said. "I don't remember how much I've told you about the natives, but we thought there were two species: one that looks a little like big six-legged otters, and another like big fruit bats. Turns out that they're the same species, but the 'otters' are females, the 'bats' male. They spend most of their time apart, but they meet in their town at the water's edge, and they're completely dependent on each other."

Magnus took his time in answering. "How many of these towns are there?"

"We have no idea. They're not obvious until you're almost inside one. But some of the Breakaway people and I have been in this one

several times, and had several conversations. Mostly with females, who are the permanent residents of the town. But last night I started learning to talk to the males, and something about how they live."

She could practically hear Magnus frowning. "'Learning to talk to the males.' Don't you talk to them the same way as females?"

"Not quite. Their mouths aren't built the same way, so they make different kinds of sounds. But the underlying linguistic structures are similar enough that the translator is picking up the male language much faster since it already knows the female. Dick Sysler—I don't know if you remember him, but he's a biologist who moved up here—thinks they diverged from an amphibious ancestor in the intertidal zone, females specializing for swimming and walking, males for flight, both comfortable enough on land to interact there."

"Hmph. I suppose I've heard stranger things, though I can't remember when." Long pause. "And I can't remember any more disconcerting. What other cheerful tidings do you have for me?"

"Well, they have technology. We're only beginning to know how much and what kinds. So far it looks pretty primitive. But they have agriculture, and they make things out of metal—some of which they get from plants and animals by methods that humans didn't start calling phytotechnology until around the beginning of the twenty-first century. They have wheeled vehicles. And steam engines, though we've only seen one and it looked pretty primitive."

"Hmph," Magnus repeated. "Primitive or not, their very existence is a huge blow to both the foundations of our faith and our plans for the future. Sister Calantha, I hardly need tell you I would much rather not have known all this. But if it's true, I suppose I'm glad I sent you there to learn about it." In her mind's eye she could see him grimacing. "Now we have to decide what to do about them. What do *you* think we should do, Sister Calantha?"

He was asking *her*? Was this a test? "Well," she began cautiously, "we can't just ignore them. They're here, and they're not going to ignore us. They may or may not be a threat to our survival or continued colonization. I'm

inclined to doubt it. Even with our limited numbers and the relatively little technology we brought with us, ours is still way beyond theirs. If it came to a fight, I think we could take them easily.”

“Do you think it *will* come to a fight? Will they try to start one?”

Calantha considered. “I doubt it. Initially they tried to scare us off—and almost succeeded. Since then they seem to be trying hard to *avoid* a fight.” She considered some more. “But the fact remains that just by being here, they’ve shattered one of our deepest beliefs: that humans are alone in the Universe and it’s ours to fill.”

“Exactly. For the less thoughtful elements of humanity, that may not be too much of a shock. They’ve pretty much just stopped thinking about other intelligences, after all the decades of looking and finding nothing. But for us, the Fruitful, it’s one of the pillars of our belief system. The best thing for us would be if we could just make it go away.”

He stopped talking, and Calantha’s throat went dry. He’d come close to this before, but he wasn’t leaving much doubt this time. She decided that, bold though it was, she wouldn’t either. “Are you talking about genocide?”

“That’s such an ugly word. I don’t like the idea, either. But sometimes one must choose the lesser evil. If it were possible to simply eliminate these . . . What do you call them?”

“Zoey. Though it’s too early to say whether that will stick.”

“Zoey. If it were possible to simply eliminate these Zoey before our people even knew about them, I must confess I’d be sorely tempted.”

Calantha had long considered herself one of Magnus’s most faithful followers, but she felt herself shudder. “Fortunately,” she said as icily as she dared, “that probably *isn’t* possible. How could we ever find them all, much less get at them when their town’s practically a subterranean fortress? Especially while keeping them and their extermination secret from your flock.”

“Are you sure that’s fortunate, Calantha? I’d think very carefully about my priorities, if I were you.” His words quickened. “And are you sure it’s impossible? I think what you’re saying is that there are only a few small

entrances to their town, so they have a strong defensive position. But that cuts both ways. It could mean they’d be easy to bottle up and then send in something that was very bad for them. We wouldn’t even have to go in personally. We do have nanotechnology, you know, and explosives and other chemicals—”

“And they have the home court advantage. They may know ways to use it that we haven’t thought of. And we have no idea how many other towns they have, or what technology we don’t know about yet. They’ve surprised us several times already.”

“True. We don’t dare let them surprise us too often. As for other towns, what good would those do them if they’re trapped in their own? And if they can somehow communicate, that could ultimately work to our advantage. If we destroyed one town, that could be a sobering example to the others—and maybe draw them out of hiding so we could deal with them, too.”

Calantha felt sick. He was serious about this! She had never before actually argued with him, and the very thought verged on blasphemy. But how could she avoid it? “Mightn’t there be another way?” she said slowly. “As you said yourself, nobody has thought much about the possibility of nonhuman intelligence in a long time. We just assumed there wasn’t any. Now that we know there is, shouldn’t we look at every possible way to rethink our position on it?”

He was silent for quite a while. “Such as?”

“How about conversion? On Earth, when Europeans colonized other continents, one of the first things they did was to convert the people already living there to Christianity—making them subservient to church authority. Might something like that work for us here? Sell the Zoey’s own theological doctrines, allowing them to survive, but with you as their spiritual leader?”

“Hmm. That might be worth considering.” He pondered a moment. “What kind of religion do they have now?”

She hadn’t really thought about that and was startled to realize what her answer must be. “I haven’t seen any evidence that they have any.”

“Ah. A *tabula rasa*. That might make them particularly susceptible to new ideas.” Pause. “Or particularly resistant. Keep an eye out for

evidence about that, Sister Calantha. But I see another problem with your idea. If we tried to dominate them by treating them as close enough to human to let them live and give them the gift of religion, it can't really be *our* kind of religion, now can it? Not the whole package."

"Why is that, Brother Magnus?"

"Don't you see? Our very name comes from the biblical admonition 'Be fruitful and multiply.' We don't want to encourage *them* to do that, do we?"

"Of course not," she said stiffly. "But if, as you said, we can't give them 'the whole package,' couldn't we give them some of it—or a modified version? Like, teach them that we came from God and are destined to fill the Universe, but we're willing to let them use a little piece of it—if they behave. Certainly there's ample precedent for that sort of thing in human history." She'd always thought the phrase "getting hot under the collar" was just a figure of speech, but now she felt it happening literally, as more words tumbled out. "Please, sir, there has to be a better way than wiping them out! I know they're not human, but they're surprisingly like us in some ways. And they seem like basically decent folks, despite some weird primitive habits like making males and females eat different diets." *Now why did I bring that up?* She hurriedly added, "Why, they even raise their babies in crèches like ours—"

"Which makes me wonder if they're doing it for the same reasons we are. I'll try to save them if I can justify it, Sister Calantha, but I can't promise we'll go that way. This whole affair is too troubling on too many levels—probably, and I mean no offense by this, more than you can understand. I must meditate and pray on it—and in the meantime, I require that you say nothing about it to anyone else. Do I make myself clear?"

After they had disconnected, Magnus stared at the phone as if it had betrayed him. Troubling on more levels than she could understand, indeed; it was troubling on more levels than even he could understand. Which was worse: to exterminate a whole nonhuman species that shouldn't even exist, or to sell them a twisted, dumbed-down version of the Truth as an excuse to spare them?

Was sparing them even a choice he could make? He—and apparently all the colonists—knew too little of these troublesome beings to be sure they could exterminate them even if they wanted to. It could even go the other way. He could imagine that the natives could have already exterminated the Breakaway colony, if they'd wanted to. What did it mean that they hadn't?

He needed to meditate and pray, all right, but he needed more than that. He needed to consult with trusted colleagues—but were there any he could trust enough? He had thought Calantha was one, but she was showing signs of becoming a loose cannon.

For now, it was his problem alone. He feared there would be a lot more meditating and praying than sleeping tonight.

XXIII.

The next human visit to Ottertown was different. It started with the usual carriage ride through the Way In, but then they stopped at the entrance to a sparsely furnished room on the outer sea cliff, with a big, uncovered window overlooking crashing waves and marsh farms beyond. "You'll get out here," Goldie announced. "Sylvie and I will be back to pick you up later."

Phil scanned the room and saw no one else there. "What's going on?" he asked. "Where are you going? What are we supposed to do?"

"Bob will be along shortly," she said. "He tells me he and Calantha learned enough last night that you can converse. We thought it good for you all to get to know him, without us females in the way. So please go in and wait. Goldie and I have other business."

A bit warily, Phil and Hazel and Dick got out and entered the room. For once, Calantha looked more at ease than they did. As the carriage pulled away, Phil reflected that this was the first time humans had been left alone inside the town. Were they really alone, or were they watched by unseen eyes?

He didn't have long to wait. Soon he heard a crescendo of wings outside, and with a few final flaps, Bob settled onto the window ledge, his slightly unnerving form silhouetted against the starry sky. He made his own kind of noises, and Calantha's translator said, "Howdy,

folks. Hope I didn't keep you waiting too long."

Phil knew such translators had come a long way in handling nuances and inductive interpretation, but he couldn't help wondering how much Calantha's own sense of humor had influenced its ways. Not that he'd ever realized she had one. . . .

This time Calantha had the advantage. "Bob, I'd like you to meet my colleagues: Phil . . . Hazel . . . and Dick. I know you've all seen each other before, but I hope tonight we can get to know each other better. Maybe I can start the ball rolling.

"You, and your fellow males, were born in this town, yet once you're grown up, you live somewhere out there, fly around a lot, and only come back here sometimes. How do you feel about that?"

Phil got the distinct impression that Bob didn't understand the question. "What is to feel?" Bob asked. "That's just . . . the way things are."

"Do you ever wish they were different?" Calantha asked. "That you could spend more time in the town, and less far away?"

"That would be wrong," said Bob. "We belong out there. Except when we come back here."

"But why—"

"Excuse me," said Phil. "Thank you, Calantha, but I think we'd like to hear Bob's own view of what his life is like, and how we've affected it and how we might affect it less."

Phil had no experience reading male Zoey body language, which was necessarily quite different from female, but he could have sworn Bob looked relieved. "Thank you, Phil," said Bob. "I'd be happy to tell you. Flying is simply a joy. To soar over the land, seeing all spread out below, seeing far, then swooping down low when see something of interest . . . Not to offend, but for you who can't do it, it must be hard to imagine."

"I believe that's true," said Phil. "Is it . . . less joy now? Since we came?"

Bob seemed to hesitate. "Sometimes," he said. "Can't deny it was scary when we started flying into your . . . what do you call them? Windmills? It was deep pain to lose friends that way. Once we began to understand what they were, we could learn to

steer clear of them—though we didn't like having to. This was our land since long before you came. Why should we have to avoid parts of it because you put strange new things here?"

"We're very sorry for your losses," Hazel said. "We never intended to hurt anybody. We didn't even know you were here, since you're mostly out by night and your dwelling places are hard to see. If we had known, we might have done things very differently." She paused. "As you know, we have stopped using the windmills, for now."

"We appreciate that," said Bob, "for now. But we fear you will soon start them up again. And while we Zoey's, being intelligent, can avoid them, the little flyers we eat cannot. If you start killing those again, that will be a big problem for us."

"But why must you eat those?" Calantha said suddenly. Everyone turned to stare at her. "Your mates and children back in the city don't. It looks to me like blatant sexual discrimination." Phil's analytical part wondered what her translator would do with that, but most of his attention was fixed on Calantha's unexpectedly acting like a full representative of Breakaway instead of just a hired technician. "Why should you have to eat bugs just because you're male?"

Bob just stared for a good many seconds. "We *like* bugs," he said finally.

"Do you really?" Calantha asked. "Or have you just been taught that you should for so long—"

"Calantha!" Hazel interrupted sharply. Calantha stopped and looked at her with an annoyed frown. "Excuse us for a moment, Bob." Hazel gestured to the translator and told Calantha, "Off. Now."

Calantha glowered briefly as if she were going to defy Hazel, but then turned the device off. "We very much appreciate your help in communicating with the Zoey's," she said, "but please remember that your job is to help us communicate with them, not to proselytize or try to foment discontent with their way of life. That's not for us to do, and we don't know anywhere enough about them to do it well. Do I make myself clear?"

"Besides," said Dick, "Bob's right. There really are fundamental differences between males and females—"

"That's how men used to rationalize oppressing women," Calantha said with a scowl.

"True," said Dick, "and completely irrelevant. The Zoey's sexual dimorphism runs a lot deeper than ours. You can see how different almost everything about their anatomy is. They're adapted to different environments; their only common ground is the intertidal zone. Your translator had to learn separate speech for males and females, didn't it?"

"Yes, but humans have also imposed different dialects on different groups to reinforce an artificial class distinction—"

"Do you really think this is artificial? Could Sylvie speak Bob's language if she wanted to? Or vice versa?"

Calantha stared, obviously seething. "No," she admitted at last. "There are anatomical differences—"

"You bet there are. I'll bet they run to their digestive systems, too. They *can't* eat a lot of each other's foods—and they can't get them where they spend most of their time. There seem to be good reasons for that, too, though we're hoping you'll help us learn more about them."

"We're immensely grateful for your help with that," Hazel said, a bit more gently. "But don't presume to speak for us. You're not one of us. We can thrash out the rest of this stuff later, in private. For now, let's just get to know him. Let him speak for himself, without trying to reshape his worldview in our image. Okay?"

"Okay," said Calantha, looking as if the words tasted bitter in her mouth. "But don't you forget that you need me." Without waiting for permission, she switched the translator back on. "Bob, I'm sorry if I offended. I believe my colleagues would like to ask you some questions."

Then she just waited.

Hazel started things off. "Bob, Sylvie said you males roam the countryside to bring things back that they can't get here. May I ask what sorts of things?"

"Many sorts," Bob said. "Some you can touch, like special rocks that the females use to make things. Sometimes things to use, sometimes just to look at."

"What if you need to bring a lot of something? One of you can't carry very much flying."

"True. Usually we just bring things that are valuable in small amounts. If we find something that they could use in large quantities . . . well, usually, we just leave it there. If there's enough, and they need it enough, and it's in a place that's easy to reach, they may build a road to take wagons there. But that doesn't happen often."

"I see," said Hazel. Phil made a mental note that much of what they could do, they couldn't do on a large scale. "What else do you bring?"

"Sometimes we bring plants or animals that females eat in addition to their usual food—just as we sometimes eat bits of theirs when we visit there." He looked at Calantha. "But neither they nor we could live mainly on the other's food. Too different."

"And sometimes," he went on, "we bring information."

"Information?" Phil asked quietly.

"Knowledge brings strength," said Bob. "If we see a storm coming before it gets here, we warn females so they can prepare. Or any other danger. In old days enemies sometimes got into town and caused trouble, fear, damage. By flying abroad, we could spot those coming and warn females to ready defenses. And we could help head them off ourselves, by attacking from the air."

"You say there were enemies in old days," Hazel said. "How about now? Are they still around?"

"Don't know," said Bob. "Not much trouble with old enemies lately." He paused as if deliberating, then said, "But we found you. Don't know yet whether you're new enemies."

"We'd rather be friends," Hazel said quietly. Phil thought, *Some of us, anyway*. As if sensing the need for a change of subject, Hazel said, "Do you like visiting the crèches?"

"Oh, yes," said Bob. "Life is joy. Sharing that joy with young is special. They are hope for future of all of us."

"We feel the same way," said Hazel.

"Glad to hear that," said Bob. "Another thing we sometimes do—" He broke off abruptly as if he'd thought better of what he'd been about to say. "Glad to hear that," he repeated.

After an awkward silence, as Phil and presumably all his colleagues wondered what Bob had started to say but didn't, Hazel said,

"I suggest we continue this conversation in our town, Breakaway. Can you come tomorrow?"

Bob considered. "I think so. But prospect is scary. I've never flown in daylight before. Among us, 'fly-by-day' is a term of derision and disparagement."

"Understandable," said Hazel. "But this time there's a good reason for it. You can get eye protection from your craft workers in town, and we can try to keep our lights from being too bright. We'll try to make you as comfortable as we can. Can we count on you?"

He seemed to be thinking it over. Finally he said, "I'll be there."

XXIV.

Phil knew from the start that Bob's first visit to Breakaway would be psychologically different from Sylvie and Goldie's. Human perceptions are strongly colored, often subconsciously, by association with past experiences. Many humans find otters cute. Few feel the same way about bats.

But Phil wasn't expecting Corcovan and his cohorts to be so blatant about it.

They were there even before Phil arrived, standing in an unruly knot at one side of the area where they expected Bob to land, brandishing placards with slogans like BREAKAWAY IS FOR HUMANS, BATTER THE BATS, and THE ONLY REAL SOLUTION—the last with crude cartoons of otters and bats lying belly-up. Phil cringed, but before he could react, Hazel came storming onto the scene, charging toward the protesters and yelling, "Get those things out of here! Right now! I said *now!*"

For a moment they stood their ground, staring sullenly. But nobody could stare Hazel down, and already a group of her supporters were forming into a small army of their own and advancing on Corcovan's gang, many of them carrying objects that could serve well as weapons.

Corcovan looked momentarily indecisive. Then he muttered something to his gang that Phil couldn't catch. They lowered their signs, backed off and dispersed, discreetly followed by some of Hazel's supporters.

But there was no feeling of resolution.

Phil moved closer to Hazel. "You handled that well—and in good time. I wouldn't want

Bob to see those signs. He couldn't read the words, but the pictures could be a problem." He looked in the direction the protesters had gone. "I don't think we've seen the last of them."

"Of course we haven't," she said. "I may have handled that well enough, but I'm beginning to think we could have handled some things better right from the start."

"Like what?"

"Well, when we moved here, we all had this idealistic vision of ourselves as a rational, well-intentioned bunch who were above the common throng and didn't need to saddle ourselves with formal government. That's easy when there aren't many people involved and things are going smoothly. But it was only a matter of time before some problem that would come up that would divide us. Once that happens—as it has—maybe we'd be better off if we had some clear rules about what will and won't be tolerated. And ways of enforcing them."

"A police force."

Hazel nodded. "Yes. It pains me to say it, but yes. I've seen this split coming for some time, and now I see the wedge being driven deeper and deeper—just when we can least afford it. In the midst of all this, can we still hope to organize ourselves *and* deal with the Zoeys? Or is it too late?"

Before Phil could answer, he heard distant flapping and saw Bob materialize over the nearest trees, then descend to land right in front of Phil and Hazel. Again a throng of villagers gathered around him, but this one was smaller and seemed more wary than the one that had greeted Sylvie and Goldie. Bob, his face partly hidden by a dark eye mask that undoubtedly made him look even more sinister to people who thought of bats that way, looked them over and said, "Howdy, y'all. Thanks for letting me come to visit."

"Our pleasure," said Hazel. "Was your trip okay, with the daylight and goggles and all? Is there anything we can do to make you more comfortable?"

"I managed," he said. "It was . . . an interesting new experience. And no, you don't need to do anything special. Just show me what you want me to see."

Hazel and Phil started by introducing them to a few of the boldest onlookers, a bunch

self-selected for high curiosity and openness to the unfamiliar. Not surprisingly, quite a few of them were kids, and Bob's standing among them and answering their questions reminded Phil a little of his visit to the Zoey crèche. But only a little: in the crèche, Bob had towered over his questioners, little "bats" and "otters" who looked up to him both literally and figuratively. Here they were aliens who, even the children, towered over him and must have seemed intimidating.

Hazel must have agreed. She let it go on only briefly before she said, "Okay, folks, that's enough for now. You'll all get chances to talk to Bob later, but now we have things to show him." As they dispersed, she told Bob, "I thought you might like to start by seeing what our homes are like. I'll offer my own as a sample." She started toward it, the humans easily following. Bob scurried along in an awkward-looking gait with quick walking motions of his short hind limbs aided by using his longer front arms as auxiliary legs and his middle wings folded out of the way as well as he could manage. But they were big wings, and after a few steps, Hazel stopped and looked down at him. "Bob, would you like us to get you a cart or something? I didn't think about our legs being so much longer than yours."

"No, I'll be fine," he said. "But thanks for asking."

They got to Hazel's house and went inside. She gestured at a coffee table in the center of the living room. "You're welcome to sit there, Bob. You'll see better from there than on the floor." He thanked her and took her suggestion with a quick hop. "We don't use it for that, of course," Hazel said. "But you're welcome to."

There were a couple of big old-fashioned books on the table, with pictures and text. Bob glanced at them, but only briefly, and Phil wondered if he had any idea what they were for. Did the Zoey's have a written language? If so, was it the same for males and females?

So much they still didn't know!

As Bob scanned his surroundings, and Hazel pointed out furnishings and lights both here and in the rooms opening off it, Phil looked around too. He hadn't been in Hazel's home since their time in Colorado and couldn't help being curious. Her furnishings were much like

his but with individual touches reflecting her personality and background—including, to his surprise, a picture of the two of them on a mountain ledge near her old place in Colorado.

He wondered what Bob would make of the electric lights and plumbing fixtures. He'd seen evidence of indoor plumbing in Ottertown, but the obvious parts didn't look much like their counterparts here. He had no idea whether the males' lodges had such things at all.

Bob made no comment on those, but he did ask, "You live here alone?"

"Yes," said Hazel.

"Is that usual among you? One house, one person?"

"Not usual," said Hazel, "but not uncommon. Some of us live alone, but many in small related groups. Often one adult male and one adult female who've chosen to spend their lives together. Sometimes their children too, if they have any."

"Interesting," said Bob. "All the time?"

Hazel frowned. "What do you mean?"

"When a male and female and their offspring share a house, do they spend all their time together there?"

"Well, not all, but a lot of it. They may all have their own things to do in different places during the day, but usually all come home to spend the night."

"Interesting," Bob repeated. "And a bit strange, if I may say so without offending."

"No offense," Hazel assured him, but Phil sensed that the topic was making her a little uncomfortable. "Let's go outside and we'll show you where our food comes from."

On the way there, they stopped off at the gathering hall, and Phil explained that this was something like the hall in which the Zoey's had first shown him their model of a human windmill and its hoped-for destruction. There weren't many people in it now, and none came over to talk or meet Bob—but most of them stared. That made Phil uncomfortable, so they didn't linger.

Outside, he pointed out a couple of crop fields and livestock yards, and asked, "Bob, would you rather fly over and meet us there?"

"That would be easier," Bob said. "See you in a minute." He took off after a rather comical

run on his middle and hind limbs to gather speed. It looked easier than Phil would have expected, but he made a mental note to try to offer some sort of raised platform for Bob's next takeoff.

Bob solved that problem for himself by perching on a fence rail next to a field where beans and corn were beginning to sprout, along with a presumably native plant that Phil didn't recognize. Bob seemed to find the idea of cultivating plants on dedicated pieces of dry land surprising. "What is that one?" he asked, pointing at a still-standing row of last year's dry corn stalks.

"Corn," said Hazel. "It's a plant from our home world that produces seeds that we like to eat. It's not easy to grow here, but we've found ways."

Bob pointed a wing tip at the native crop. "But this one is not from your world. We eat it too."

"That has problems for us too," said Phil. "It's easier to grow than the plants we brought from our home world, but we have to do extra things to it before we can eat it." He hoped Bob wouldn't press him for details. How could he possibly explain nanotech to the Zoey's—and would he even want to?

"Would you like to go see the windmills?" he suggested.

"I've seen them," said Bob, with what Phil suspected was some version of a grimace. "But never from this angle. Yes, I'd like to see them. This time I'll definitely fly ahead, if you don't mind."

"Understandable," said Hazel. "But we'll be driving up. Want to ride along?"

"No, thanks. I'll fly, and watch where you go."

Hazel and Phil picked up Luk, just in case any technical questions came up, and all the humans piled into a bug to head up the switchbacks to the windmill farm. Bob literally flew circles around them as they climbed, then landed and sat on the bug's roof when they parked it near the base of a windmill.

There were no corpses or fresh litter of flying "insects" on the ground this time, the windmills having been out of commission for several days. Phil was grateful for that, but Bob still hit on a touchy subject right away. "What are they made of?" he asked. "I

don't recognize the material. Same with your houses."

Phil had been afraid that would come up, so he had thought a little about possible answers and wasn't caught completely off guard. "It's something we brought with us," he said. "Actually, we grow them. A little like growing plants, but different."

"Could you teach us?"

"Probably not," said Luk. "We may not always be able to do it ourselves. To maintain it we need other tools that we couldn't bring with us."

"Hmm," the translator said Bob said. "How do they help you? Why do you need them?"

Phil had given that a little thought, too. "You remember the conveyor belt that hauls things up from your marsh farms to the city, and the engine that drives it? The windmills provide the driving force for many of the things in our town. But they get what they need from the wind rather than steam."

"You mean energy," the translator said, which startled Phil until he remembered the time he had inadvertently used the word to Sylvie, and she had seemed to understand it right away. "But how can a windmill up here drive things in town?"

"That's hard to explain," said Phil. "I don't fully understand it myself."

"Understood," said Bob. "We have things I don't understand, too." He paused. "We appreciate your shutting them down while we work this out, but I'm concerned. How are you managing without them?"

The question, and especially the way he phrased it, surprised Phil. "It's some hardship," he said, "but we're managing. We have other ways to do the most important things, for a while." He hoped he wouldn't have to try to explain antimatter power supplies. "But we can't keep doing it indefinitely."

"I hope you won't have to," said Bob. "For both our sakes."

Phil was feeling pretty good about the way things had gone as they drove back down the hill, but he felt a sinking feeling as they approached the spot where Bob had arrived and from which he would leave. Corcovan and his cronies were back, signs and all, in a semicircle right where Bob would presumably be taking off, blocking his obvious run-up path.

Bob and his human escorts had already begun saying their good-byes as they approached, but Bob broke off what he was saying and came to a nervous halt as he saw what lay ahead. He stared at each obstructing human—and each sign—in turn. His eyes lingered longest on the one with the cartoon of dead Zoey males and females. Then he turned to Phil and asked quietly, “What does this mean?”

“It means,” said Phil, “that some among us have bad tempers and not much sense. Pay no attention to them.”

He knew that was a nonsense suggestion even as he said it, but he tensed painfully as the encircling mob edged deliberately closer, jeering rudely and brandishing their signs. “No, Batface,” Corcovan said with a sneer, “that’s not what it means at all. It means—”

“*That’s enough!*” Hazel interrupted in a tone that stopped even Corcovan in his tracks. “Corcovan, we’ll deal with this later. For now, you’ll show our guest the same courtesy you would expect if you were visiting in his home. Or you’ll get out of here, right now. Do I make myself clear?”

Corcovan just glared at her. Then he started to take another step toward Bob. “*I said now!*” Hazel yelled. Then, glancing at a couple of her closest associates who “just happened” to be armed, “Clarify!”

They drew their weapons and stepped resolutely toward Corcovan. He stared incredulously, then glowered. “You bet we’ll deal with this later,” he growled. He turned to his associates. “Later,” he said, quietly but ominously, and they moved off.

“That was most disturbing,” Bob said when they had gone.

“To us, too,” Phil and Hazel said together. “But remember that your people don’t all agree about how to deal with us. Then maybe you can understand that we have the same problem.”

“Maybe,” said Bob. “But now I must go.”

“Understood,” said Phil. “We’ll look forward to our next meeting.”

“I wish I could say the same. But we will meet again soon. And now, good—” He was starting his run to reach takeoff speed when a small, high voice called out, “Wait!”

Bob stopped and looked for the source, perhaps because Srella sounded so different from

the other humans he’d just met. “Please, sir,” she said. “Mr. Bob. I’d just like to meet you, too.” She was staring more obviously than she had with Sylvie and Goldie, and seemed a little afraid to get too close.

“Well, here I am,” he said, staring back. “And you are . . . ?”

“Srella. I just wanted to tell you I hope we can all get along. I don’t want any more bad things to happen.” She looked down at the ground and said, “My mother was one of the ones who . . . died.” Then she looked straight into his eyes, though none of the humans could actually see them through his dark shades. “Did you kill my mother?”

Bob was caught so off guard by her question that for a long moment he made no response at all. Then, just as he was starting to attempt one, there was a flurry of loud footsteps headed this way, and a man’s voice off to Phil’s right shouted, “Srella!”

Phil recognized him just as he puffed to a halt in front of them and grabbed Srella’s hand: Olaf Lindholm, her father, though few would guess that by looking at the two of them. Despite the abrupt way he had announced his arrival, Phil remembered him as a powerfully built but soft-spoken Scandinavian biochemist who had played a key role in making it possible for humans to grow Earth crops and digest native ones. “Srella,” Olaf repeated, speaking only to her, “don’t bother our guests.” He told Bob, “I’m her father. I hope she hasn’t been bothering you. She didn’t mean any harm.”

“She hasn’t bothered me at all,” said Bob. “I find her . . . refreshing, after some of your fellows I just met. And her question is a fair one, though the answer isn’t as simple as you might think.”

“No need to go into detail,” Olaf said hastily. “At least now.” He turned to Phil and Hazel. “I hope she hasn’t been causing you any trouble, either. She gets curious about things, and sometimes plunges right in without asking.”

“No problem,” Phil assured him. “Actually, she was a big help in getting as far as we have. I don’t know how we would have managed without her model-building skills. You should be proud of her.”

“Well, I’m glad to hear that. Still, I should keep better tabs on her. I’m not as good at it as Giselle was, and now that I don’t have her—”

"No need to apologize," said Phil. "I'm sorry I haven't come to spend any time with you since I got here. I was very sorry to hear about Giselle. How have you been managing since . . . ?"

"I manage. I won't say it's easy." He took a lengthy moment to compose himself and his thoughts. Then, to Phil's surprise, he addressed Bob. "I don't know how I feel about you folks. On one hand, after spending my life assuming humans were the only intelligent life there was, it's exciting to learn that there's somebody else. Part of me wants to get to know you, to learn all I can about you—just as Srella's mother would have wanted to do. Another part fears that you did cause her death and wants to hate you for it. But I know—or think I do—that you're not all responsible for what one or two of you did." Phil saw his lower lip trembling slightly. "So you'll understand that I, too, am interested in the answer to my daughter's question."

"I do understand," said Bob. "I find talking to you reassuring, and I hope to be able to give you a good answer later. For now, I'll just say that we never meant any harm, just as you say of us. Anything that happened before was an unfortunate accident, and we regret—"

He broke off abruptly, suddenly staring over Phil's shoulder at something behind him. "We really do regret," he said. "But we shall have to finish this discussion later." Without another word, he turned away, did that frenzied run, and was airborne, flapping off just above the trees.

Phil turned around to see Corcovan, alone, striding this way with fierce determination in his face. "Coward!" he muttered, watching Bob fly away. Then, glaring at Hazel, "You said everybody would have a chance to talk with him. I want mine."

XXV.

This time it was Magnus who woke Calantha with a call. She was sleeping soundly, dreaming of herself as a little girl back in Kansas, running happily through cornfields and giggling. Then her father, whom she had always admired more than anyone, whisked her up and told her the whole family was moving to St. Louis, and suddenly they were there. At first the crowds and hustle made her afraid, but once they were settled in, she found she

had more friends than she had ever had before.

Till Daddy told her they were bad people, and she couldn't play with them any more. That tore her: she had always felt deep down that whatever Daddy said, she could trust. But now he was telling her that her friends were bad, and she felt just as sure deep down that they were good.

What was she to believe?

In her dream, her head was physically splitting, one side trying to pull her being back to Daddy, the other trying just as hard to pull her away from him and off to join her new friends forever. The pain was excruciating. She felt her body and soul splitting right down the middle, opening along an actual zipper that she hadn't known was there—

It was at that moment that the rasping sound of the zipper morphed into the insistent beeping of her communicator. Confused, she dragged herself up out of the dream and reached out to answer it—but remnants of the dream clung to her like mud on a person climbing out of a puddle she'd fallen into.

"Hullo?" she mumbled groggily.

"Magnus," a voice said, and it took her a moment to relate it to a person. "Sister Calantha," it said. "We have to talk."

"Now?" she said. "Brother Magnus, I know I disturbed your rest once before, but I apologized—"

"I know, and I made you promise you wouldn't do it again unless you had news so important it couldn't wait. I wouldn't do it to *you* unless it was that important, either."

She struggled to process that. What could have happened at his end that was that important? This was where the action—and the trouble—was. "Then you clearly did the right thing," she said, more out of duty than conviction. "What is this thing that couldn't wait?"

"I've made my decision," he said. At first she thought with annoyance, *What decision?* Then she abruptly realized what he must mean, and the fog cleared immediately, replaced by an unbecoming wariness.

Why should she be wary? He was Magnus. If he had a decree to make, her duty was simply to accept and follow it.

"The last time we talked," he said, "I found your news deeply troubling. I told you that I needed to meditate and pray, but at first that

didn't seem enough. For a while I also felt that I should seek counsel among my peers. But then I realized that that very thought was but a momentary weakness. You see, Calantha, even I am subject to moments of such weakness.

"But I have long cultivated the inner strength to rise above it, and I soon realized that showing it to my fellows would only foment confusion and weaken our people's faith and thereby our cause. There was only one individual whose counsel I needed, and it was a flaw in my faith that I ever considered anything else."

"And that individual would be . . . ?"

"Why, Sister Calantha, isn't it obvious? God, of course."

She was silent for a long time. "God spoke to you? Directly?"

"He's been speaking to us for a long time. Think back to our credo, based on the correct interpretation of Genesis. The King James version says he gave humankind dominion over the Earth and all that lived on it." A detached part of Calantha wondered what it really said. She'd never read it in the original, and, as a linguist, she knew what could happen in translation. "We now know," Magnus was saying, "that that merely reflects the limited perspective of the translators, and what they rendered as 'Earth' really meant the entirety of creation, of which Earth is but a small part. Is that not so?"

"So we are taught," Calantha said stiffly.

"Because it is true. We are really meant to have dominion over *everything*, not just our little Earth, and the Gate was a gift from God to open our way to this new planet. Anything that appears to be somewhat like us, or to want a share of that dominion, must be a test. We must not be deceived. We were commanded to have dominion, and dominion we shall have. It's all right there, in the revealed word.

"But yes, since you ask so directly, God *has* spoken directly to me, to confirm that this is what he wants. It is what we must do."

"We must destroy the Zoey's?"

"It's the only sure way to have dominion over them."

Calantha was shaken. "How can we have dominion over them if they no longer exist? Couldn't we try what I suggested instead?"

"Try to control them with a distorted version of the Truth? That would be a betrayal of the Truth itself, and of the God we serve. I cannot be a party to that."

"You'd rather be a party to genocide?"

"Regrettably," he said with exaggerated piety, "there is no other way."

She could hardly hear her thoughts over the hammering of her heart. Finally she said, "But . . . how can you do that?"

"We," he corrected. "Not me. We're all in this together."

"We," she said dully, the word tasting bitter. "How can we do it? A successful general must know his enemy. There is so much we don't know about the Zoey's. How many of them are there? What are their strengths and vulnerabilities? How many more are there besides the town we know about? How much contact do they have?"

"Details," said Magnus. "Obviously we will not plunge into this blindly. We shall learn these things. Since you're there and I'm here, I'm counting on you to be my eyes and ears. To learn all you can and report back to me, with a full awareness of why we need the knowledge."

"Oh," she said—and no more.

He waited quite a while and finally said, "Sister Calantha, I need to hear your answer. Are you with me or against me?"

She, too, took a long time to answer. Remnants of her interrupted dream were rising up and wafting around her, making her think, *Even daddies can be wrong*. . . . At last, very conscious of what a bold, dangerous, disquieting move it was, she said, "I can't be with you. Not on this."

"Then you are against me," he said quietly. "Not a good position to be in, and a profound disappointment to me. But I can be as magnanimous as my name. I will make allowance for the unfamiliarity of what I am asking, and the possibility that your judgment is simply warped by the concerns of the moment. Call me when you change your mind—regardless of the hour. But my patience is not unlimited."

He broke the connection.

XXVI.

To Phil's surprise, it was Corcovan who called for a general meeting and took the initiative by calling it to order. Most of the

village was there, and since there was not—so far—a formal government, anyone could call a meeting of anyone who cared to show up. Hazel called Phil right away and asked him to attend with her. “I don’t know what he has in mind,” she said, “but I think we’d better find out and be prepared to defend ourselves if necessary.”

Phil agreed, so now they found themselves side by side near the front of the gathering hall. Corcovan took a commanding stance at the very front and boomed out, “May I have your attention, please? Your attention, friends!”

It took a moment for the gathering to fall silent, but it did. Clearly Corcovan had followers. “I’ve asked you to come here,” he said, “because we’ve been living under unusual stress for quite a while, and some of us think it’s gone on long enough.”

“It’s only been a few days,” somebody called out.

“Some of us,” Corcovan repeated, “think that’s several days too many. Several days without our windmills. Several days of unnecessarily depleting our valuable antimatter reserves, which we’re in no position to replace if we use them up.”

“A few days don’t matter,” the heckler interrupted, and a small murmur of voices and countervoices began to swell.

Somewhat to Phil’s surprise, it was Hazel who cut them off. “Let the man speak!” she shouted.

Corcovan looked as surprised as Phil. “Thank you,” he said with a wary glance at Hazel. “As I was saying, we’ve had several days of having our privacy invaded by nonhumans invited here by a few among us for the express purpose of showing them how we live. That’s information they could use against us, and we should be thinking real hard about whether it’s smart to let them have it. Meanwhile, those same few among us have been spending long hours among the enemy on their own turf—”

“I object to your calling them the enemy,” Hazel interrupted loudly. “We don’t know that.”

“We don’t know that they’re friends, either.”

“And we’re collecting similar information about them.”

“Just as I was about to say,” Corcovan said with a smug grin. “That’s what you say you’re doing, but most of us have heard very little of your findings—or what else you might have been discussing over there. I think it’s high time we did, especially if you expect us to continue putting up with what we’ve been putting up with. And you’ll have to convince us of that.”

“That can be arranged,” said Hazel. “We’re still learning so much that it won’t be a finished product, but we can certainly prepare a report on our findings so far, for everybody to read.”

“Good,” said Corcovan. “You do that—because we’re going to have to make an important decision soon.”

“Right. So are they. And since this involves both them and us, we ought to have some Zoey representatives in on these discussions.”

Scattered cheers and catcalls floated up from the gathering. “I hardly think so,” said Corcovan. “The most basic decision we have to make is whether we’re going to try to coexist, or one or the other of us has to go. Surely you can all see why we don’t want them here until we know which way that goes.”

“On the contrary,” said Hazel. “I don’t think we have any right to make that kind of decision without giving them a chance to defend themselves. Remember something in the American constitution about the accused having a right to confront the accuser?”

“This isn’t America, and they aren’t human.”

“Exactly. Isn’t that exciting?” Without being asked, she rose from her seat and strode to the front of the room, turning right beside Corcovan to face the audience. “Folks, let me remind you of a few things about how and why we came here. There was a time, which some of you are old enough to remember and some of you aren’t, when people dreamed about meeting other intelligent species from other worlds. They didn’t want humans to be alone in the Universe. They thought meeting others would give us an unprecedented opportunity to see everything from a new perspective and exchange ideas, much as human civilizations had long done among themselves. Some wanted that enough to put a lot of money and effort into searching for extraterrestrial intelligence.

"But after years of coming up dry, the very idea that there was anybody else out there—out *here*—faded away. We quit looking, and began to take it for granted that we were alone. We couldn't expect company, but by the same token it seemed the Universe was ours for the taking.

"How we wound up here is a story too long and complicated for me to tell in detail here and now, but if you don't know it, I strongly suggest you look it up. The gist of it is that an interstellar probe sent out before we collectively lost interest wound up sending signals back from a place a long, long way from where it belonged. Nobody official was paying any attention to the incoming signals by then, but a young academic working in the history of science on Luna stumbled onto this one and realized what it must mean: that that probe had hit something in space—what we now call the Gate, and assume to be the product of an alien technology that we don't understand—that catapulted it through a short-cut to a distant region of space. There it found this planet, surveyed it, and found that it was eminently suited to human habitation, and apparently without intelligent inhabitants. Not that the probe looked all that hard, given a Zeitgeist that had pretty much abandoned the idea of ETI as a serious possibility."

"Maybe it should have looked harder," somebody said with audible bitterness.

"Maybe it should have," Hazel agreed. "But it might have missed the Zoey's even if it had, given that they're nocturnal and their civilization is so hard to see from outside that it might as well be deliberately hidden. In any case, that's irrelevant now; we don't get a redo.

"That same young historian, who you all know as Phil Bertrand, had been e-corresponding with another young academic—that would be me—on Earth. My specialty was an old branch of literature called science fiction, which had faded away when the real world became so much like its imaginings of the future that most people didn't see much difference any more. Ironically, that led to my stumbling onto another piece of the puzzle that ultimately brought us here. While researching some of the last stories thought of as distinctly science fiction, I stumbled onto records of another bit of real research that had been largely forgotten: Renton Ingvall's mole drive.

"That's sometimes described as 'burrowing through subspace,' another concept I couldn't explain in detail and you wouldn't want me to. What matters is that it lets a ship get from one point to another at apparent speeds greater than what used to be called the light limit—but not enough greater to get us all the way out here in a reasonable time. But it could get us out to the Gate, and that could plop us out close enough to get here in a respectable total time.

"I don't remember which of us first thought of putting them together, but when Phil told me what he'd learned and I told him what I'd learned, we both saw an exciting possibility. Like most of you—maybe all of you—we'd become terribly tired of what Earth had become. We saw this place as a chance to try again—quietly bring a few dozen carefully selected people out here and start over, trying to treat our new planet right from the start, avoiding the mistakes our ancestors had made.

"It took years to pull it off, but we did. Most of you were among the few we invited and were proud to call friends, colleagues, and co-pioneers. We never expected to find anything here but room and resources, and when the Zoey's started making themselves known—admittedly in a weird and disconcerting way—we understandably saw them at first as a threat.

"But maybe that was wrong. Maybe we should see them instead as an opportunity that our forebears had long hoped to find and given up on. Now it's been given back to us. We need to remind ourselves why it was worth seeking, and learn to take advantage of it."

"They're primitive," Corcovan interrupted loudly, apparently having had enough. "They kill humans."

Hazel stopped and looked at him. "Can you prove that? And even if it's true, was it 'they,' or just one or two of them? Can we hold an entire species responsible for the actions of a few? Would we want them doing that to us?" She turned back to the general assemblage. "Look, friends, we still don't know exactly what happened in those frightening early days—which were not very long ago. But we do know, from what we've learned already, that there's far more to them than our early dark imaginings. Let me give you a few—"

"Put it in the report," Corcovan broke in. "We've listened to you long enough, especially considering that I called this meeting." He, too, turned back to the audience, leaning toward them and gesturing earnestly and emphatically with his hands. "Listen, friends—and I think I have at least as much right to call you friends as she does—we can read what they claim to have learned later. For now, I want to make sure you fully grasp and appreciate one key fact that overrides anything else. *These creatures have killed some of us!* Do we want to let them do it again?"

A considerable number of voices shouted, "No!"

But they were by no means a clear majority, and as they faded, a single, much quieter voice said, "May I say a few words about that?"

Suddenly the room became very quiet as eyes sought and found the speaker. Here and there jaws dropped, and the one man standing in the middle of the room walked calmly forward, holding Srella by the hand, and the two of them took a position in front of both Hazel and Corcovan. "If anyone here has a right to be angry or vindictive about those deaths," Olaf Lindholm said in his usual calm voice, "it's me and my daughter. She lost her mother; I lost my wife, my finest colleague, my irreplaceable soulmate.

"But are we putting up a battle cry and demanding vengeance against an entire people—yes, I said people—because one or more of them may have been responsible for Giselle's death? We emphatically are not. Probably the Zoey's—*some* Zoey's—really did cause what happened. Bob, the one of them that I've gotten to know a little—has hinted as much. But he also said that it was an accident. Until I see more evidence to the contrary, I consider that a plausible hypothesis that deserves to be tested. Especially since we, too, have accidentally caused injury and even death among them."

An angry murmur started in a couple of pockets within the crowd, and Olaf let his voice rise just enough to cut it off. "Don't deny it. You know about the bodies, large and small, among the windmills—and you know that wasn't what we had in mind when we set them up. It couldn't have been; we didn't even know the Zoey's existed then.

"But now we do. And Srella and I know that if Giselle had lived to know it, she would have considered the chance to get to know them the opportunity of a lifetime. If we don't want to dishonor her memory, we have to learn to see it that way too."

He stopped deliberately, sweeping his eyes over everyone in the room. Finally his gaze came to rest on Corcovan, just for a moment, and then he looked back at the group. "I know some of you don't agree with me. But we have to decide how we're going to handle this, and we have to do it like rational beings. We can't just plunge ahead with whatever impulses we feel and let the decision be made by whoever has the hottest head and the biggest hammer.

"We need a better way of making group decisions than we've had—or needed—since we came to New Horizons. I suggest that we begin by agreeing to some basic democratic procedures, and electing a leader—right now."

Scattered applause began here and there and grew into a steady roar punctuated by cheers. Then, as if that process had somehow cleared the air, the chaos rapidly coalesced into a semblance of order. It didn't take long to establish that most people at least grudgingly accepted Olaf's suggestion, and that the obvious candidates for an elected leader were Hazel and Corcovan. A voice vote was held less than half an hour later. It was too close to call, so they tried again by counting raised hands, and that gave Hazel a clear majority—but not a large one.

Looking surprised but tentatively gratified, she said, "Thank you, my friends. I realize I don't represent all of you now, but I'll do my best to make sure we work toward a consensus we can all accept."

Corcovan, though visibly disgruntled, at least had the sense to recognize that he needed to seem willing to work within the hastily established system. "And I," he said, "will do the same. But don't think you've heard the last of me."

His expression was such a cryptic mixture of feigned good humor and veiled threat that nobody was sure how to respond. The result was a round of halfhearted applause that gave Phil less hope than he might have preferred.

And as that faded away, a completely unexpected woman's voice said clearly, "Before you all go, may I say something?"

XXVII.

As Calantha stood to speak, her heart was hammering even more loudly, and the rest of her was shaking harder, than in her last conversation with Magnus. It didn't help that most of the audience was staring at her as if astonished that she should think she had anything to say.

So she cut right to the chase. "I'm asking you," she said quietly, "for asylum."

The room became even more hushed, as if everyone had stopped breathing. "I can't go home," she went on. "I always assumed I would, but I've been put in an impossible position. Partly my own fault, because I find I have to be true to my own beliefs, and I've just learned what those actually are. I think.

"As you know, I came here because you asked me to, and you had a problem that interested me. I had no delusions that you wanted me here; you needed me, which is not the same thing. I told Luk Zakowitz when he invited me that I would need permission from our leader, Magnus, and a condition for getting that was that Magnus expected me to keep him posted on my findings. I naively thought he would be as excited as I was to hear about the Zoey's. I can hardly tell you how shocked I was when he called me last night and told me God has told him that . . . I must help him do something I can't even say."

She closed her eyes briefly. "But I couldn't accept that. As some of you know—and others probably don't—the Fruitful are not really a religious body. Some of us are; I thought I was. But when the chips came crashing down and I had to really examine what I believed, and why, I found that I was one of the many who tagged along not because we believed strongly in Magnus's preachings, but because we liked some of the other ideas that came with them.

"Me, I just like children. I've always been more comfortable with them than with most adults. When I found out about the Gate and New Horizons and Magnus's plan, I was excited about the possibility of living

in a place where people could again have big families and enjoy them without apology.

"But there are limits to what I'm willing to do to protect that. When Magnus told me God had told him I had to do more . . . I did a hell of a lot of soul-searching and finally decided I didn't believe God had told him anything. He's just a charismatic man who's let power go to his head, and he's scared.

"I'm scared, too—but I'm also excited. I've gotten to know the Zoey's a little, and I'm eager to know them better. I've seen their children; I've seen Bob bonding with them. When Magnus said I had to keep sending him information so he could use it against them, I told him I couldn't. He expects me to call back soon and tell him I've changed my mind. But I'm not going to. If I send information to anybody, it will be to my few friends who I think will see it my way.

"That makes me his enemy. If I go back there, I'll be regarded as a traitor. My life would be in imminent danger from the moment I stepped out of my VTOL.

"But if you let me stay here, and accept me into your community, I'll be more than willing to help you continue to learn all we can about the Zoey's. I know some of you would like to use that knowledge the same way I would." She glanced involuntarily at Corcovan, then tore her eyes away. "I also know some of you wouldn't. But no matter what side we're on, we need the knowledge before we can decide what to do.

"So what do you say?"

She closed her eyes, trying to stop her trembling as she waited for their answer. The silence went on a long time.

Finally Hazel said, "I sympathize with your situation, but this is a big decision for us. You're right, though, that we need the information before we can move on. And we need you to get it."

"I don't trust her," a Corcovan supporter growled—but not, Phil noted with interest, Corcovan himself. "She's still one of *them*, no matter what she says. I don't want her here any longer than necessary."

"Well, we haven't reached that point yet," Hazel told him. "Right now, her presence—and help—is still necessary. So we're going to have to give her the asylum she wants, at least

for a while. Whether that turns out to mean indefinitely, remains to be seen.”

She turned to Calantha. “Calantha, I’m sorry we haven’t made you feel as welcome as we might, but you can understand why you make some folks uncomfortable. We are grateful for the help you’ve already given us, and appreciate your willingness to keep doing so. I can’t tell you you’ll be welcome here indefinitely. Eventually there will have to be a vote, and how that goes will depend partly on how you impress people in the meantime. Personally, I hope it will work out to everybody’s benefit. I want to know more about the Zoeyes too, and it’s no secret that I oppose extermination or anything like it. But what we ultimately do is everybody’s decision, not just mine.

“Meanwhile, I want to know more about Magnus and his plans. . . .”

“Actually,” Luk remarked to Olaf when the pandemonium died down and the gathering hall had mostly emptied, “that was something of a relief. Looking back a year from now—if we’re still here a year from now—I think we’ll feel lucky Calantha wanted to stay with us.”

“Yes,” Olaf agreed. “I’d hate to have this degenerate into an orgy of mutual destruction when we’ve made such a promising start on understanding each other. Giselle would have hated it even more. She would have loved to be doing what Calantha is doing, you know.”

“Yes, I know,” said Luk. “And I’m so sorry she couldn’t be the one to do it. We all miss her. But I was thinking of even more than that.”

“So was I,” said Olaf. “Aside from the adventure and romance of getting to know an alien intelligence, I think we’re going to need them—and maybe sooner rather than later. As enemies, they’d just drain our limited resources. As friends, they could help us learn to use a fair share of the ones we’re trying to share with them.”

“Yes. They’ve had a lot more practice than we have, and I can already see the stuff we brought with us starting to fade. That’s why I started the windmill project. Our antimatter power systems aren’t going to last forever, and we’re a long way from having the infrastructure to replace them. So I wanted to start developing ways that we could carry on with

just local sources of energy and materials if we ever have to.”

“*When we have to,*” Olaf said gently. “We’re both tech guys; we can speak plainly to each other about what we know is coming. You grew your windmills with nanotechnology that has the same problem: increasing entropy, and we’re less and less able to do anything about it.” He glanced around to see who might be listening. “I assume you’ve noticed how old Calantha looks?”

Luk nodded. “I don’t know how many rejuvenate treatments she’s had, but I don’t think they’re working as well as they used to. Nanotech systems do break down, and there’s less and less we can do for it. And rejuvenes are the least of our worries.”

Olaf grinned wryly. “Oh, you think mere survival is more important? Well, you’re right, of course. I ought to know. Do you know how much I had to do to enable us to grow Earth crops here, or let us digest native stuff? And I’ve never thought of it as more than a stopgap. If we really want to be at home here, we need simpler and surer ways to survive without constant dependence on artificial aids.”

“That’s a tall order,” said Luk. “But the Zoeyes’ natural adaptations may give us some good ideas. And their ways of doing things may help us see ways we could do them better. Have you heard about this phytotechnology Phil says they have?”

“Yes, and I can’t wait to learn more. . . .”

The next time Magnus got a call from Breakaway, he frowned as soon as the caller started speaking. That voice was definitely not Calantha.

“This is Rod Corcovan,” it said, in male tones that struck Magnus as rough-edged. “You don’t know me, Mr. Magnus, but we have something in common.”

Magnus bristled at being called “Mr.” Magnus. “What could that possibly be?”

“We both see the native creatures we’ve found as a threat to humanity. We both see what needs to be done about them, but not everyone sees it our way.”

“How do you know that?”

“Your spy talks too much. Or should I say your former spy?”

Magnus sat up straighter, frowning but listening attentively. “Who do you mean?” He

knew the answer, of course, but he wanted to feel out what this Corcovan character knew and what his angle was.

"I think you know. Calantha McQuade. The linguist you sent over here to help those among us who want to treat these primitive beings as equals—and incidentally to gather information about them for you. I understand she's let you down lately."

"That's between her and me," Magnus said stiffly.

"Of course," said Corcovan. "But maybe it's more than that. How long since you've had a new report from her?"

"Why should I tell you?"

"Have you told your people there about your plan to exterminate the natives?"

Magnus frowned. "Did Calantha tell you I had one?"

I wish I did, he thought glumly. A goal is not a plan.

"Not in so many words, but I read between the lines. Do you deny it?"

"No," Magnus said with a sigh. "I'm waiting for the right moment. But it won't be long."

"Presumably," Corcovan said with irritating smugness, "because you'd like to know more before you go public, and you're not getting it from Calantha any more. How would you like another source?"

Magnus perked up but remained cautious. "What do you mean?"

"She's still helping a few of us—not including me—gather more information about the bats and otters. They've promised to put together a report on what they've learned so far, and keep providing updates as they get more, supposedly to help us here make an informed decision when we vote on what to do. I'm guessing you'd be interested in that information, too."

"Maybe. Are you offering to supply it?"

"Maybe. If you can't trust Calantha to any more, I'd be more than willing."

"Why? What's in it for you?"

"Isn't it obvious? I want the same thing you do. But I'm not sure there are enough of us here to pull it off, by ourselves. There are a lot more of you folks. If we got together . . ."

"It's worth considering," Magnus said carefully. "Do you speak for everyone in Breakaway?"

"Unfortunately, no. There are some here who think like your renegade linguist. They think they're going to use the information she's helping them gather to get all cozy with the natives, and we'll all live happily ever after. You and I know that isn't going to happen. They're way too different."

"Indeed." Magnus thought it over. "This is very interesting, Mr. Corcovan. Most of us have always thought the main conflict on this planet was between you First Settlers who ducked out to Breakaway, and us Fruitful. But if some of you agree with us . . . well, that could make things a lot simpler in the long run, couldn't it?"

"Only about this," said Corcovan. "We only agree with you about the native problem. On the population question, most of us in Breakaway still agree that we need a place to live very differently from you. But since some of us agree with you on what to do about the local creatures . . . well, they say politics makes strange bedfellows. This may be a case in point."

"It may indeed." *He doesn't see the bigger picture, Magnus thought. If some of them align with all of us on this issue, when it's all over there may not be enough opposition to keep the Fruitful from following our mandate on the whole planet.* Aloud, he just repeated, "It may indeed. Please do keep me informed, Mr. Corcovan. Let's see if we can help each other toward a worthy goal."

XXVIII.

Magnus had plenty of confidence in his power and his popular support, but he nonetheless felt a bit apprehensive when he put the word out that he was going to make a big announcement. Only after he made that "preannouncement" did he call his advisory council together.

He knew Newtown had a much better organized government than Breakaway. With its much larger population—several thousand compared to a few hundred—it had to. But he also knew that he was the heart and soul of it. These people were his devout followers; he needed a council mainly to make it unnecessary for him to get involved in petty details and to keep him informed about developments and trends that could grow into major problems if not nipped in the bud.

Today he sat at the head of the big table in his private conference room and surveyed the handful of faces around it. He'd handpicked all these people, but it was disquieting to reflect on how little he actually knew about them. The discomfort didn't last long, though. They all had a good record for acting as his eyes and ears and then rubber-stamping his decisions. Why should today be any different?

Maybe, an annoying little part of his brain suggested, because what you're asking them to do is different from anything in their past experience? He squelched that part quickly and called the meeting to order.

"Thank you for coming," he said. "Something has come up that completely upends much of what we believed about this world, ourselves, and perhaps the Universe. It does not change what we need to do, in the long run, but it does require us to do one additional thing that we never imagined we would ever have to consider.

"As you well know, one of our most fundamental beliefs is that we humans are alone as intelligent, sentient beings, so the Universe is ours to fill and utilize as we see fit—as God wills us to see fit.

"We have no reason to doubt that essential truth—but our former compatriots on Zo have discovered something that threatens to confuse the unsophisticated and shake their faith in it. That's a chaotic landscape over there, and literally hidden among its nooks and crannies they've discovered a kind of life with enough superficial resemblances to us that some might mistakenly believe they have as much right to this place as we do.

"This, my friends, is a test God—or perhaps Satan—has placed before us to see how easily we could be swayed from our sacred mission. There are some among our renegade cousins who think we should try to reason and cooperate with these beings. To *share* with them!" He spat the word out with obvious distaste and paused to study the frowns and questioning expressions before him.

Before he could continue, Shun Lee, long one of his most trusted advisors, said, "You say these beings bear a superficial resemblance to us. You mean they look like us?"

"No, no," said Magnus. "Not at all. If you must compare them to anything, the females look a little like the otters we had on Earth,

and the males a little like bats—big bats. I haven't personally seen them, but this is what I've been told."

"Otters and bats," Shun Lee mused. "That hardly sounds possible. How can they be . . . compatible?"

"I don't know," said Magnus. "But that's an unimportant detail. Presumably they have found ways."

"Clearly very different from ours," said Shun Lee. "So how can you say they superficially resemble us?"

"Some aspects of behavior. They have towns—or at least one town. That's all the Breakaway colonists have seen, and it's not easy to see, so we don't know how many more they might have missed. And they have some technology, though it seems to be quite primitive."

"I gather," said Shun Lee, "that we don't know a great deal about them yet. How do we know what little we do?"

Magnus had been hoping that question wouldn't come up, though part of him knew it had to. "You may have noticed that you haven't seen Calantha McQuade around lately. You may also have seen one of our smaller VTOLs take off some days ago, and noticed that it hasn't come back. Calantha took it, with my blessing. One of the Breakaway people asked her to come and try to learn to communicate with the natives. I wasn't entirely convinced that was a good idea, but the very existence of these creatures was disturbing enough that we needed to learn as much about them as possible—before I bothered you with the question of what to do about them."

"Don't the Breakaway people have their own linguists?" Adrian Beaufort asked.

"They did. They don't any more. There is . . . reason to suspect she was killed by natives."

That provoked a small flurry of small but agitated conversations. Finally Beaufort said, "And after that, we're still considering trying to talk to them?"

"They claim it was an accident, if they had anything to do with it at all," said Magnus. "That's not inconceivable. We've had accidents, too." It pained him to say the next part, but he felt a need to have all the cards in the table before this group, if not the colony at large. "The people who've been trying to talk

to them say they seem to be of good will. They claim the natives seem to be making an effort to live peaceably with us, and think we should do the same."

"And they were here first," said Shun Lee. "That is awkward, isn't it?"

"To say the least. The question before us today, gentlefolk, is whether we should attempt to deal with these beings, or whether that might be suicidal in the long run. I've made my decision, and God tells me it's the right one. I'm counting on you to give me your support as well."

The assemblage sat silent for quite a while, and none of their expressions were easy. Finally Shun Lee said, "This is too important to expect us to read between the lines. Why don't you tell us, straight out, what your decision is?"

Magnus sighed. "I'll do that. It might seem, on casual consideration, that trying to get along peacefully with these beings, perhaps even to cooperate with them, would be required by the moral teaching of our faith. Certainly that would be true if they were human. But they are not human, and encouraging people to treat them as if they were would undermine our even more fundamental teaching of humanity's uniqueness and our mandate to fill the Universe to the best of our ability. Furthermore, at a more pragmatic level, we will be competing with them for the same resources.

"For all of these reasons, we need to remove them from the picture as quickly and unceremoniously, and with as little discussion and agonizing, as possible."

He waited. The silence was even longer this time. Finally Noreen Beaufort said carefully, "You're saying we should exterminate them?"

Magnus nodded solemnly. "A regrettable necessity. Remember, these are not human beings. This will not be a question of homicide."

"But it is unquestionably genocide," said Shun Lee.

"Do not think of it that way," Magnus warned. "Think of it as a surgical operation needed to ensure our own survival and prosperity. If we knew there were lots of other places to go, and we had ways of getting to them, we might have the luxury of trying to find a gentler way. But we have nowhere else to go, and no way to get anywhere else."

"We have a whole planet," said Shun Lee.

"And we're filling it at a rate far beyond anything in past human history. You've all seen the numbers. This is a relatively hospitable world, and in addition to an opportunity that has not existed on Earth in recent centuries, we have an unprecedented combination of advantages enabling us to take full advantage of it. We have biological technologies like life extension, rejuvenation, cloning. We have social inventions like baby farming and neural implants to accelerate learning so people can become productive members of society at early ages. We have nanotechnology to make building infrastructure faster and less labor-intensive.

"The upshot is that our population doubling time is about sixteen Earth years. True, there are only five thousand of us now, but there were only two thousand when we arrived twenty years ago. If we continue on the same path—a path for which we are divinely destined—there will be twenty million of us in a couple of centuries, and twenty *billion* in less than four. So while most of the planet is unpopulated now, it won't be long before we need all of it. Now is the time to nip obstacles in the bud."

Shun Lee, with deeply furrowed brow, said, "Why? These natives are, as you said, primitive. They can't have any of the advantages that let us multiply so fast. Why not wait until it's more definite that we have a clear numerical advantage over them?"

"Because," said Magnus, "we don't need that numerical advantage, and it's better to stop an incipient problem at the earliest opportunity than to put it off and hope it will get easier later. Things seldom work that way. Our best bet is to strike decisively, now, while it's pretty clear that we can do so successfully."

"What makes you so sure we can?" Adrian Beaufort asked. "What do we know of their numbers and specific abilities? What weapons will work against them? What defenses do they have and how might they retaliate?"

"Enough," said Magnus, trying to sound as confident as he wished he felt. "Calantha and the people she's working with are preparing a summary of their findings so far. Calantha herself, I'm afraid, has become a bit of a loose cannon—"

"Exactly what do you mean by that?" Noreen interrupted. "And how do you account for it?"

"She's become one of the bleeding hearts who think we should try to work with the natives, with some vague idea that we can all live happily ever after. She doesn't like my plan, and has threatened to stop supplying—"

"Doesn't it bother you," Noreen asked, "that she opposes you so strongly, when she probably knows more about the natives than any other human?"

"Of course it bothers me," Magnus snapped, "but not because I think she might be right. The point is that you have all sworn allegiance to me as the leader of this colony, and to the sacred purpose on which it was founded. Calantha has lost perspective because she's standing too close to the problem. I'm confident she'll come to her senses and back into the fold. But just in case she doesn't, I've been contacted by a member of the Breakaway group who does agree with me and wants to work with us to make sure my plan is carried out. He has promised to keep sending me reports even if Calantha doesn't. We will have an ongoing source of intelligence from Zo, and we should get some of us over there soon to check things out for ourselves.

"Meanwhile, the important facts we already know are these. There is only one native settlement near Breakaway. The natives are smaller than us, have far less sophisticated technology than we do, and are not much, if any, more numerous. They're bottled up in a compact target. A swift, fairly conventional attack and a show of our superior strengths, which must seem like magic to them, should put an end to the immediate threat. If we learn there are more elsewhere, we can tailor a biological or nanotech weapon to take care of them afterward.

"As for Calantha McQuade's current misbehavior, that's a passing aberration and a good illustration of why we must move ahead promptly. Otherwise our people will confuse themselves with too much thinking about how this unexpected discovery should affect our worldview.

"So: are you with me? I want to take this to the people very soon. And I want to be able to tell them that this council unanimously backs my plan."

The ensuing silence was the longest yet. Then Shun Lee pushed his chair away from the table and stood up. "I'm afraid the 'unanimous' part isn't going to work," he said. "I quit."

"So do I." Noreen Beaufort stood up and followed Shun Lee out the door, neither of them looking back.

Magnus stared after them, trying to control his trembling. Then he forced his attention back to the remaining members of the council and, keeping his voice firm with an effort, called for a vote.

And was relieved that his proposal did pass unanimously among all those still in the room.

He went public the next day, announcing a meeting of "utmost importance" to be held in the largest public space in the town—the open field people called "the square" even though its shape was nowhere near that regular. He also set up to send his announcement out electronically for anyone who didn't want to show up personally but was curious.

The in-person turnout was impressive. He stood on a high dais, decked out in full regalia, before a sea of some two thousand souls, and felt confident that there were at least as many unseen but listening.

His presentation to them was to the point, but less detailed than the one he'd given his private council. As he expected, the announcement that their strayed brethren in Breakaway had discovered seemingly intelligent life provoked gasps. "This is not the end of the world," he assured them. "It is merely a test God has placed in our way, to ultimately strengthen our faith in our divine mission.

"We must never forget that we have no way to leave this planet. The Gate is gone; we could see its functioning becoming more erratic as our successive ships came through, and the last one didn't make it. The ones that did make it, we have long since cannibalized to build our burgeoning new home. It will be a long time before our descendants can build new ones. And as well as we could determine experimentally, the Gate never did work in the other direction.

"So this planet is our future. We cannot risk it by attempting to share it with creatures that could seriously compete for its resources.

Some of you may be uncomfortable with the idea of destroying beings whose behavior looks superficially a little like ours, but my council, myself, and above all our God, have determined that there is no other way. If ever in the course of human history a choice really had to be made between 'Them and Us,' this is it.

"If you have doubts, I ask you to ponder your faith until you see the wisdom of this choice. If you are already on board, I ask you to come forward without delay. We have already begun collecting, with the help of sympathetic persons in Breakaway, the information we will need to carry out our mission. But we must not rely solely on them.

"The very name of their settlement—Breakaway—makes clear that most of the inhabitants of Breakaway have already broken faith with us. So while we welcome the information they send us, we must also have some of our own people over there to see for ourselves what the situation is and what we can do about it.

"I'm organizing an initial party, right now, to fly to Breakaway and set up a base camp for scouting out the situation. There has never been such an opportunity for men and women of courage to provide a great service to their people. If you would like to volunteer, please come forward right now. If you're not quite ready, go in peace, and I shall look forward to your joining us later. God be with you!"

He stood with benevolent arms outstretched and said no more. For a moment, the crowd was hushed, then a mighty roar of cheers broke out, and people began streaming toward the dais. Only a couple of hundred, he estimated, but even that was more than the first large VTOL could carry.

It had gone well, he thought. That had been a gratifyingly loud round of cheers, and he'd heard no obvious jeers among them. A small doubting part of him wondered if that meant that the common people were more solidly behind him than the council—or that those opposed were too stunned to say anything yet.

He chose to believe the former and to revel in the adulation of the smaller but energetic crowd now gathering at his feet, pressing forward and clamoring to be among the first

chosen. "Choose us!" he heard one couple cry out. "We've got a boy over there. . . ."

And they were just two among many. Yes, he assured himself, this was going to work.

XXIX.

Despite the rumblings of brewing trouble from Magnus and Corcovan, after the big meeting things seemed to settle down into a comfortable routine. The small human delegation and their Zoey counterparts continued to visit and study each other, but Phil increasingly felt that there was more than study involved. Different as these beings and their ways were, he was coming to like and respect them—and to feel surprisingly at ease with them.

Still, he reminded himself periodically that disturbing questions remained unanswered, and he needed to keep thinking about those. One morning a few days after Corcovan's meeting, Phil took advantage of a shortish night in Ottertown to get up after a relatively brief sleep and go out for a stroll among the ruins scattered through Breakaway.

There hadn't been any new activity there since the visits started, but the mysteriously half-collapsed houses and such were still much as they had been. He paused next to the first one he'd seen, staring at the ground at its base and letting his gaze go half-focused and his mind wander where it might. He remembered when his little group had stopped by one of these, and Dick Sysler had asked Sylvie how they did all this damage without setting off alarms or leaving tracks.

It wouldn't do to leave tracks, she'd said; if it was obvious how it was done, it wouldn't be scary. She'd indicated that they'd done it by controlling swarms of small creatures that they brought to the "job site" and left them alone to do the dirty work. But she'd been sketchy about details. Now Phil found himself trying to imagine how the blanks might be filled in.

How, for instance, did they get the destructive little beasties to where they were needed, without whoever brought them leaving tracks? What made them stop when they were finished, instead of just continuing to wreak havoc indefinitely?

Well, given that the Zoey males were the very "bats" whose corpses he'd seen with so

little idea of their import, the track question was easy. Maybe one of them could fly over the site they wanted to sabotage and drop a bag of the mini-destroyers—or eggs that would grow into them. If the Zoey delivering the package flew at just the right height, he might be able to drop it without significant damage, while staying above the visual field of camera traps.

As for the destroyer bugs' doing only so much damage and then disappearing, maybe they were programmed in some way. Or maybe they just had short life spans and were all males, or sterile, so they couldn't reproduce. But that wouldn't account for why their bodies weren't found in the rubble. . . .

Or were they? Phil remembered the unpleasant sense of the ground crunching underfoot because he was walking on thousands of dead flying bugs. How closely had any human examined those? Might some of them be the destructive agent? Did their sheer numbers keep people from noticing them? Or could the destroyers be the flying bugs themselves?

If they really weren't there, maybe that was because they left when they were finished. Phil tried a new scenario. Maybe even before Zoey males airdropped bags of tiny destroyers, they laid down some sort of invisible fence to keep the bugs' destruction within a well-defined boundary. Maybe the boundary lost effectiveness over time, so the bugs could wander off, either finished with their destruction or, as isolated individuals, doing too little damage to attract notice.

Too many hypotheses; too little data to choose among them. Phil couldn't exactly say he was on the right track, but he felt that he was standing at the junction of the right track with several wrong ones. All he had to do was figure out which one it was. . . .

But before he could pursue that very far, or even get very excited about it, he was distracted by something new and totally unexpected.

At first it was just a distant drone, almost too faint to register consciously. But it drew his eyes toward the western sky, and there his peripheral vision caught a tiny dot, moving and growing almost imperceptibly. Over the next couple of minutes it grew louder, and bigger, and took on shape. As Phil realized what that shape was, his jaw dropped from

sheer astonishment. Then he began to worry about what its presence here might mean.

He had forgotten about everything else by the time the VTOL had settled into a vertical orientation above the hanging plain where the windmills stood and begun settling toward the ground. He watched just long enough to be sure it was really landing, then turned and ran headlong toward Hazel's house.

"It's some of *them!*" he told her breathlessly, as soon as she'd let him in the door. "They've followed us here! In a VTOL! A big one!"

Hazel frowned but otherwise remained outwardly calm. "Sit down," she said, gesturing toward her couch. "Who's followed us here? Let's take this from the top, slowly."

"We may not have time to take it slowly." He sat as directed but remained on the edge of his seat, leaning anxiously toward Hazel. "I was outside thinking about the ruined houses and windmills, when I heard and saw something flying this way. When it got close enough, I saw that it was a human-built VTOL. Now, who could have one of those on this planet?"

Hazel's mouth took a grim set. "The Fruitful. Now why would they suddenly be coming here, and with no advance notice?"

"I can't think of any good reason," said Phil.

"Neither can I. But I can think of several bad ones. Do they think they're going to set up a branch office right next to us? Turn Break-away into another Newtown? If so, what does that mean for us?"

"Well, at the very least, there goes our dream of making this our kind of place instead of theirs. But it could be even worse. Do they want to try to browbeat us into going back there? Or sabotage our settlement?"

"Why bother?" said Hazel. "We're no threat to them over here."

"Not now. But maybe they've started really thinking about how fast their population can grow, and decided to eliminate us sooner rather than later."

"Yes, I suppose it could be an actual invasion. It seems bizarre, but so does a lot of what they do. You say this is one of the big VTOLs?"

"Yes. Big enough to carry our whole population."

Hazel frowned intently. "I don't like it. If it's any of those things, it's not good for us."

"Of course," Phil mused, "maybe we're not who they're after. Remember what Calantha said about Magnus's idea of destroying the Zoey's. Could they be planning to try that already?"

"That would make no sense at all," said Hazel. "The first rule of conflict is 'know your enemy.' What do they know about the Zoey's?"

"Maybe more than we think." Phil paused to let that sink in. "Or maybe they're here to start learning."

"I don't like that any better than the other possibilities," Hazel said after a while. "I think we'd better go up and ask them—with an armed escort."

Combat had not been high on the list of things either wave of colonists expected to do, so there wasn't a lot of weaponry or training among them. But they had anticipated a possible need for hunting or defense against predators. It didn't take long to round up a couple of sympathetic souls with long guns, and in less than an hour, Phil and Hazel were back in a bug, winding up the rough road to the windmill field with the two gunmen in the back seat.

When the road smoothed out onto the plain, Hazel gasped at the sight of the VTOL standing proudly among the windmills—and at what was going on around it. Dozens of people were scurrying among the windmills, setting up instatents and moving gear into them. Evidently they were here for the long haul—which was no surprise, after they'd gone to the trouble of moving that many people all the way here.

Hazel looked around but didn't see anyone obviously supervising. She just drove up to the nearest tent, got out, and strode up to the biggest man outside it. Phil, following close behind, didn't recognize the man; it had been a long time since anybody knew everybody else in Newtown. "Hello," Hazel said neutrally, looking the man in the eye. "I'm the elected leader of Breakaway. Who's in charge here?"

The man by the tent stopped what he was doing just long enough to say, "That would be Burl Sanderson. The guy over there in the

orange hard hat." He pointed, then looked at Hazel and added, "He would have come to see you in a little while, if you'd waited."

"Couldn't wait," said Hazel. "I need to talk to him before you people get too settled." She climbed back into the bug, told the tent man, "Thanks," and drove off to see Burl.

He was as burly as his name, no doubt chosen for his leadership role because of his intimidating appearance. But Hazel did not look intimidated. "You're Mr. Sanderson?"

He made a point of looking down at her. "Yes. And you are . . . ?"

"Hazel Castagna. What's going on here?"

"We've come to help you," he said gruffly. "We understand you have a pest problem."

"I don't remember asking for help, and polite people generally call ahead before showing up on other people's doorsteps. What kind of problem do you think we have? And why did you assume we'd be so eager for your help that you don't have to bother with manners?"

"Don't give me that," Sanderson growled. "You know perfectly well what problem you have. Some people here still talk to friends back home, you know. We know about the others and bats. We're here to get rid of them for you."

Hazel glared. "You must also know that a lot of us consider that a really bad idea."

Sanderson made a little travesty of a grin. "Yes. I also know some of you don't. Some of you have the sense to realize that these critters can be nothing but trouble for human plans. We—" He broke off, frowning, and looked off in a direction where conversation had suddenly become loud and agitated.

Several of the new arrivals were looking toward the VTOL and pointing toward a sizable winged form flying toward it. The flyer made several circles around the big craft, then spiraled out for a broader survey of the assembling multitude. When it got close, Phil recognized it and smiled. "Hi, Bob!" he called out.

He knew Bob might not understand him, and he couldn't read Bob's expression as he flew by and then off toward higher ground. But he suspected Sanderson's reaction should be interesting.

He wasn't disappointed. "Bob?" Sanderson said, glaring.

Phil nodded amiably. "That's what we call him. We can't pronounce his name for himself, but he can't pronounce ours, either. But we get along."

Sanderson radiated disgust. "You know that thing?"

"Yes," Phil and Hazel said together. "And some of his kinfolk, too."

Sanderson shook his head. "Ugly thing." He took a moment to compose himself, then drew himself up and looked haughtily down at Hazel. "I'll be coming down to visit in a while. I especially want to talk to Rod Corcovan. Since you're about to go back down there anyway, why don't you give me a ride down?"

"I can think of all kinds of reasons," said Hazel, "beginning with the fact that I haven't invited you, and you haven't asked if it's all right. So it isn't." She paused very briefly. "I can't tell you you can't come, though our village as a whole may decide to later. But I don't have to welcome you, and you'll have to get there on your own." She gestured at the nearest couple of windmills. "Meanwhile, don't touch anything up here. I'll leave Rocky and Brad in case you need any help."

She gestured at their bodyguards in the back seat of the bug, and they got out, conspicuously displaying their weapons. Then she and Phil got back in and drove back down to Breakaway. As they pulled away, Phil noticed a couple of the newcomers staring at him with what looked like hostility. They looked faintly familiar, but he couldn't quite place who they were.

Even before they got there, Bob swooped down next to them and paced the vehicle the rest of the way, flying gracefully a few meters to one side. As soon as they stopped at the edge of town, he swooped down and landed on their hood. Hazel opened the window and Bob chattered animatedly but incomprehensibly.

"Hang on, Bob," Hazel murmured. "I know we've got a lot to talk about, but we need help." She pressed a com button, waited for an answer, and said, "Calantha, we've got a situation here and need an interpreter. Can you come out to Bob's landing spot right away? We're all in a bug."

Calantha showed up a few minutes later, only minimally burdened by the latest version of her translation gear, and stood outside, leaning on the bug and standing so she could face everybody else. "Hi, Bob," she said. "What's up?"

Bob pointed toward the windmill plain with a wingtip. "New machine up there," he said. "Big. Just came, with many others like you all. They seem to be fixing to stay. What's going on?"

"We wish we knew," said Hazel. "These are people from the old home we left, and we didn't ask them to come. We're not sure why they did."

"We don't like it," said Bob. "When you came, we were afraid of what your arrival might mean for us. Then we got to know you some and seemed to be working things out. Now these new ones are here, and we're afraid again. Are *they* planning to do something to us?"

"We hope," Phil said carefully, "it's just a dispute between two groups of us with different ideas about how to handle things here. We hope we can work it out with them, and you won't need to get involved at all."

"I hope so too," said Bob. He seemed to hesitate, then added, "When it was just your first group and we thought you might be dangerous to us, we figured we could overpower you if we had to, but hoped that wouldn't be necessary. If there are this many more of you, that would be harder. If more are coming, and we see them as a threat, we may not be able to wait much longer before taking action."

"Well, we certainly hope that won't be necessary," said Hazel.

"We all hope," said Bob. "But we are not sure. We feel threatened again." With no further words, he flew off into the distance.

Phil, feeling suddenly chilled, looked at Hazel. "Do you think we should have been more candid with him?"

"Not sure," she said. "I do hope we can resolve the situation with these newcomers, but I'm not at all confident about that. I fear he's right to feel threatened." ■

To be continued . . .

In reading, as in most other pursuits, we *do* love our categories. And why not? Well-drawn categories are extraordinarily useful. The modern publishing industry spends untold effort putting literary works into particular categories, and then helping readers to identify those categories. We call this process “marketing” and decry it as superficial and manipulative.

Yet despite our insistence that “you can’t tell a book by its cover,” try to imagine the nightmare world that would result if there were no categories, and all books had identical featureless covers with no blurbs, no summaries, only author and title? (Actually, I don’t *have* to imagine it—it’s the world in which an adolescent me stumbled across a plain-covered public library copy of Saul Bellows’ *Mr. Sammler’s Planet* . . . which was decidedly *not* the novel I was expecting.) Trust me, you *want* to be able to identify books and stories by category.

So yes, categories are useful. In a way, *Analog* itself is a category: a place where Trevor gathers and presents works that fall into the category we call “*Analog* stories.” On the title page you’ll see those works grouped into other categories that convey useful information to readers (Novelettes, Short Stories, Science Fact, Reader’s Departments). Even here in the Reference Library, you’ll notice that I include genre categories for the books I review.

And yet, and yet . . . there’s something unsatisfying in the way we use categories. We tend to view them as intrinsic and immutable, like fast-food cups (medium, large, jumbo) or candies (red, yellow, blue, green). We imagine that all our categories operate like classic Linnaean taxonomies, defined by authoritative checklists: a creature that has hair, gives milk, and reproduces through live birth is a mammal (and nothing else).

This is how we spend so much time attempting to pin down exact definitions of “science fiction” and “fantasy,” or arguing whether the movie *Gravity* was science fiction or not. We *want* our categories to have rigidity, because we fear that non-rigid, unfocused categories will lose their usefulness. And let me tell you, there’s even worse waiting out there than *Mr. Sammler’s Planet*.

Recently the New York State courts have been embroiled in arguments over categorization. Because New York taxes the sale of sandwiches differently than other foods, the exact definition of the category called “sandwich” has great import. Is a burrito a sandwich? Is a taco? How about a slice of pizza (especially if you fold it in half before eating)? A veggie wrap? A buttered bagel? Soup in a bread bowl? A dumpling?

It’s clear that a binary model of the “sandwich” category just won’t do . . . it’s not a simple yes/no choice. Instead, we need a more (ahem) analog model. A burrito is more of a sandwich than a dumpling is, just as a dumpling is *more* of a sandwich than a cucumber is. And any of these things is more of a sandwich than a steel ingot.

So it is, I suggest, with most of the categories we use in our reading. Take a broad category like “SF.” As a thought experiment, one could evaluate every published book and give each a numerical score of SF-ness. At one end of the scale would be unquestioned SF titles like (I’ll defer to decades of Hugo voters here) Isaac Asimov’s *Foundation* series. At the other end would be . . . oh, I don’t know, what’s the *least* SF-ish book ever published? The Toledo, Ohio phone book? In the middle, a vast continuum of books, each fractionally more or less SF than its neighbor. At some arbitrary value we would set a threshold, decreeing that any book above this line belongs to the category “SF.”

Similarly, we could do the same thing with categories like fantasy, steampunk, time travel, space opera, and a million others. Every book could (in theory) be ranked against every category, so that each book would have its own set of scores.

Under a scheme like this, consider one of our favorite arguments: Is Anne McCaffrey's *Dragonriders of Pern* series SF or fantasy? The answer would be, "Well, it scores x on SF and y on fantasy. Since both x and y are above their fields' thresholds, then yes it is SF, and yes it is fantasy."

In some sense, that's not an emotionally satisfying answer. Intellectually, we know that a book can belong to more than one category at the same time—but we don't necessarily like it.

Yet—and here's the really sweet part—as far as we know now, *this is how the human brain works*. Our thoughts take place within a neural network, and any given thought causes the firing of associated neurons. If enough of the proper neurons fire, then an associated concept enters consciousness. If you're looking at a burrito and enough "sandwich" neurons fire, then that burrito is, at least within your skull, a sandwich.

So let's look at some books that will hopefully make enough of your proper neurons fire.

A Borrowed Man

Gene Wolfe

Tor, 304 pages, \$25.99 (hardcover)

iBooks, Kindle, Nook: \$12.99 (e-book)

ISBN: 978-0-76538-114-9

Genre: Psychological/Sociological SF, SF Mystery

As a general rule, when writers start to write about writers, readers should start to be careful. It's usually a sign that before long, things are going to get awfully meta. There might be different levels of reality flying about, symbolism crashing down hither and yon, and you're apt to get bonked on the head by a Meaning or two.

As another general rule, when Gene Wolfe starts to write about something, readers should relax and follow him wherever he leads, in secure knowledge that the journey is going to be well worth it.

And when Gene Wolfe starts to write about clones of dead writers living on library shelves waiting to be checked out, well . . .

It's a new world, about a hundred years from now. The population is a lot smaller, there are more robots, and there are clones. In particular, there are borrowed people: clones who host the recorded personalities of dead authors. In particular, the main character of *A Borrowed Man* has the memories and personality of Ern A. Smithe, the author of *Murder on Mars*.

Smithe's life is peaceful and uneventful until the day Colette Coldbrook checks him out. Colette is the scion of a wealthy family, and she needs Smithe for a particular purpose. It seems that her murdered father was clutching a copy of *Murder on Mars* when he died, and Colette is sure that the book contains a secret—a secret that could unlock her family's vast fortune.

Reluctant to involve the police, Colette has unsuccessfully tried to find the secret herself. She borrows Smithe in order to get access to his memories and perhaps solve the mystery.

And then it gets complicated.

This is Gene Wolfe at his best: an engaging mystery; a tongue-in-cheek social satire; an examination of the relationship between author and reader; and a serious meditation on identity, individuality, and personal responsibility—all rolled into one fun book. Don't miss this one.

Mother of Eden

Chris Beckett

Broadway Books, 480 pages, \$15.00 (trade paperback)

Kindle: \$7.99; iBooks, Nook: \$9.99 (e-book)

ISBN: 978-0-8041-3870-3

Series: Eden

Genre: Other Worlds

In 2014's *Dark Eden*, Chris Beckett introduced the world Eden: a sunless planet of lantern trees and night leopards. The human population of about five hundred, descendants of the first settlers, struggled for survival until population pressure split the community. In the resulting chaos, brothers John and David Redlantern became the leaders of two warring factions.

Dark Eden was a triumph of social world-building, down to an effective and well-thought-out dialect in the tradition of Anthony

Burgess's *A Clockwork Orange* or Robert A. Heinlein's *The Moon is a Harsh Mistress*.

Mother of Eden picks up the story about two hundred years later. Starlight Brooking lives in a small fishing community that's been relatively isolated from the still-raging wars. Until she meets Greenstone, a traveler from a continent across the sea called Worldpool. When Starlight returns with Greenstone, she discovers an advanced society with some secrets. She also finds that she's expected to fill the role of Ringwearer—a symbolic Mother of all folk on Eden.

But the more Starlight learns, the less sure she becomes about her new home . . . and the more certain she becomes that she doesn't want to be Ringwearer.

The Eden books are reminiscent of Ursula K. Le Guin or the late Theodore Sturgeon: a combination of alien societies in turmoil with language that can only be called lyrical. If you read *Dark Eden* you don't need me to tell you to read this one—and if you haven't had the pleasure, you deserve to treat yourself.

Gateway to Never

A. Bertram Chandler

Baen, 649 pages, \$14.99 (trade paperback)

iBooks, Kindle, Nook: \$8.99 (e-book)

ISBN: 978-1-4767-8047-4

Series: Rim Worlds

Genre: Space Opera

This sixth and final omnibus concludes Baen's reissue of the Rim Worlds series by A. Bertram Chandler. The protagonist, Commodore John Grimes, is one of those swash-buckling space heroes based on Horatio Hornblower—but Grimes is definitely his own man, a bit of a rogue and not always trustworthy, yet a true hero.

This volume collects the last three Grimes novels along with some shorter works. In *The Gateway to Never*, Grimes and his crew visit one of the worst planets in the galaxy. *The Dark Dimension* takes Grimes into an alternate universe where he meets another version of himself and characters from other Chandler books (and even a few from Poul Anderson's work). It's a grand adventure. And *The Way Back* tells how Grimes and his folks, displaced in time, search for lost Earth.

In addition to the three novels, this volume also includes half a dozen Grimes short stories, including one that's never appeared in book form before. And as a special treat, there's also an autobiographical essay by Chandler, "Around the World in 23,741 Days."

This book, like the previous volumes, is a must for anyone who likes space opera . . . as well as anyone who's a fan of the old Ace and DAW SF paperbacks.

Deco Punk: The Spirit of the Age

edited by Thomas A. Easton and Judith K. Dial

Pink Narcissus, 246 pages, \$15.00 (trade paperback)

ISBN: 978-1-39056-09-2

Genre: Original Anthologies

We're familiar with the genre of steampunk, which brings the sensibilities of the Victorian and Edwardian Ages to science fiction and fantasy. Now Thomas A. Easton and Judith K. Dial have taken the next step, with an original anthology that brings together stories based on the Art Deco aesthetics of the 1930s and 1940s. It's an interesting choice; as the editors point out in their introduction, this is the period that birthed modern science fiction as a distinct genre; it was an age in which change was in the air, and technological progress was an exciting new idea.

In an even dozen stories, fourteen writers ring changes on the basic concepts, and as you would expect it's a varied lot.

Paul Di Filippo takes pulp superheroes as his inspiration in "Airboy and Vooda Visit the Jungles of the Moon," in which a famous sky adventurer and a jungle queen travel to an inhabited Moon to defend the peaceful Black Leopards from the dastardly White Apes. In Jeff Hecht's "Mr. Tesla's Radio Rainmaker," a pair of Long Island mechanics enlist science rockstar Nicola Tesla to solve the problem of the Dust Bowl. In "Corn Fed Blues," Catherine Asaro and Kate Dolan tell the story of a small-town jazz singer and her encounter with an unusual time traveler. And in Melissa Scott's "The Wollart Nymphs," the daughter of a shipbuilder boards the liner *Nereid* on an expedition to chase down her sister vessel, now a ghost ship.

Other authors include Rev DiCerto, Debra Doyle and James D. Macdonald, Duncan

Eagleson, Linda Tiernan Kepner, Edward M. Lerner, Shariann Lewitt, William Raciot, and Sarah Smith.

The editors readily admit that Decopunk may not be the next big thing in SF, but nevertheless, this is a darn fine group of stories.

Press Start to Play

edited by Daniel H. Wilson and John Joseph Adams

Vintage, 506 pages, \$15.95 (trade paperback)

Kindle, Nook: \$9.99 (e-book)

ISBN: 978-1-1018-7330-4

Genre: Anthologies

In a world in which new video game releases bring in more money than new movies, it's not surprising that SF should eventually turn to the concept of the video game itself. Daniel H. Wilson (author of *Robopocalypse* and *Amped*) and John Joseph Adams (editor of *Lightspeed* and *The Best American Science Fiction & Fantasy* series) have selected 26 stories, by as many authors, inspired by video games.

I have to clarify that these aren't stories based on *specific* games; you're not going to find any Halo or Skyrim stories here. Instead, these are stories about gamers, gaming, and the field of video games. Or, as editor Adams says, "... narratives that explore the way we create and experience video games[.]"

Some of the authors are well known for their work in the video game industry: Chris Avellone, Austin Grossman, Marc Laidlaw, Micky Neilson, and Rhianna Pratchett. Others are more names from SF/fantasy: Corey Doctorow, Hugh Howey, Ken Liu, Seanan McGuire, Catherynne M. Valente, and Charles Yu. Seven stories are reprints, while the rest are published here for the first time.

Among the standout stories is Holly Black's "IUP," in which a dead gamer's friends discover a game he wrote, a game that leads them on a desperate chase to—just possibly—restore the life he lost. In "Stats" by Marguerite K. Bennett, a privileged pharmaceutical rep gets a much-needed lesson in diversity via a powerful video game. Cory Doctorow's "Anda's Game" brings a paid video gamer face-to-face with the real enemy behind the anonymous players she's been killing in games.

There's plenty of variety in this volume, from outright comedy to deeply meaningful stories questioning the economics and ethics of games and the gaming industry. Whether you're a hardcore gamer or an occasional dabbler, you'll find much enjoyment and even some food for thought between these covers.

And now I see that I've entered the category we call "out of space." Until next time, enjoy.

Don Sakers is the author of *Children of the Eighth Day* and *Meat and Machine*. For more information, visit www.scatteredworlds.com. ■

BRASS TACKS

Dear Editor Quachri,
Congratulations on being editor for the 1,000th issue! I love the idea of using a 1930 cover but with a modern twist.

I was delighted to see a special feature devoted to Campbell. He well deserves to be remembered. Ben Bova did a fine job in the space he had. If he had covered all there is to say about Campbell, it probably would have required the entire issue! I hope you will publish more articles about Campbell.

I'm a second generation *Astounding* reader. I grew up reading Campbell's editorials and feel he taught me how to think. That's why I hope more can be written about him, because in recent years, there are some who seem determined to discredit him. What is forgotten is how playful he was intellectually and how much he loved controversy. Only in his final years did he seem to lose his spark and became dogmatic. The rest of the time, he seemed to be thoroughly enjoying saying things that would spark debate. Bova alluded to that in his article, but I think it should be expanded on.

Another area to explore is how many of the classic stories originated with ideas tossed out by Campbell. Asimov always credited him with the idea for "Nightfall"—That is, Campbell asked what would happen if people could only see the stars every few thousand years. Apparently, that happened a lot.

I've heard that the classic "The Cold Equations" was the result of Campbell working with the author until he got it right. Since Tom Godwin never wrote anything else nearly as superlative, it's likely that this is true.

And I must say that I am in total disagreement with Ben Bova on his comment on "The Cold Equations." He says the pilot forces the girl out the airlock. The story would not have the impact it does if that were true. The pilot explains the situation to her. Once she understands, she grows from the impulsive teenager to a true hero who writes a farewell letter to her parents telling them it wasn't the pilot's fault and then voluntarily walks out the

airlock. And that makes the story upbeat because it is a story of growth compressed into a short time.

Again, congratulations on the 1,000th issue!

Marian Powell

Prescott, Arizona

Dear Editor,

I have become more and more annoyed by the increasing appearance of the word "reigns" appearing where the word "reins" should appear. When I saw this occur in your editorial, I was roused to actually write. *Analog* has been my favorite magazine since 1958. I look forward every month to its arrival. When you took your place as editor I had fears that changes would be made to the ancient formula that supplies the type of stories I appreciate but I have been pleased so far. Please continue the good work.

Jeffrey W. Shook

Right you are! That particular goof is in the original draft of my editorial, too, so I can't even blame it on an overzealous auto-correct. Alas, just because I know the difference doesn't mean I always catch the error.

Dear Mr. Quachri:

Colossal congratulations for reaching the unmatched (in the SF field) 1,000 mark. I especially enjoyed the fascinating statistics presented by Mike Ashley, indexer extraordinaire. One small correction, however. Jack Williamson's reign as *Analog's* longevity champ is even longer than Ashley thought. His last appearance was in April 2005, which makes the span from his first to final contribution a truly astounding 74 years.

I have slightly more than half of all your 1,000 issues on my shelves, and I am looking forward to the centennial issue in January 2030.

Marc Russell

Los Angeles, CA

Trevor,

WOW! One thousand issues!! A real milestone. Small issue to pick with you: the cover

art. Where's the cowering cavewoman? It's a dude in the background, man. The spacesuited . . . err . . . flightsuited figure looks more like a woman than the guy in the background! And you missed a REAL opportunity with this one. You should have reprinted that first story and included a story from the first issue in the next 11 monthly issues or until the whole magazine had been reprinted. Would have been nice for all us longtime fans who never saw the original issues. I've been reading your magazine since the '60s. No subscriptions till the '80s I think. Couldn't afford them, and, besides, there were other places in New York to pick up the magazine. Not so much in New Jersey or PA, but in NYC it was easy. I'll probably continue reading it as long as I'm around. It's my one vice left to me. Anyway, keep up the good work. Great magazine and hopefully it will continue for another 1,000 issues.

Bill Seiler
Chambersburg, PA

I did toy with the idea of reprinting at least that story, but in the end, I decided that using the space for new content offered you, the reader, better bang for your buck (even though it would have saved us a few).

And to address your quibble with that cover art detail: I'm guessing you missed the last footnote in the editorial.

Dear Messrs. Quachri and DiFate:

I was ready to pen a six-paragraph ode to DiFate's 1,000th issue *Analog* cover, praising his revision of the voluptuous-blonde-in-skintight-spacesuit-menaced-by-BEM trope—including the heroine's short hair-do, which is more sensible than long tresses for space helmets.

Then I read your editorial. Oh, well.

Richard M. Boothe
Sunset Beach CA

Great minds think alike, my friend!

Dear Mr. Quachri:

Analog is indispensable as a forum for putting play accessibly into our lives. That's play with ideas, with language, with story elements, with identity, all at a serious level where the quality of what is unexpectedly discovered matters to all our navigation of all our personal realities. When Campbell, Jr. changed

the magazine name to *Analog*, I thought it more limiting than I wished, even though it implied a mechanical, engineering like idea of something that literature does. It "hardened" the product extra. But his own compelling stories weren't really hard SF, not as hard as the military stuff he published by favorite authors again and again. And in fact, the story value was all-important to him. Witness non-military writers like Asimov that he nourished. I think it was a good decision, however, to take a stand for rational thinking about content by changing the magazine name to *Analog*. Sometimes, a name might merely gild a lily that is best appreciated for what it is without any distracting window-dressing. Therefore I have come to embrace the name *Analog*. The *Analog* stories are astounding, as they cannot help but be in taking play seriously.

This seriousness toward play I feel you do with distinction above all *Analog* editors thus far. I loved your editorial, composed throughout consistently with that virtue, seemingly naturally just the right length for its purpose, a real feat. Campbell, Jr. intentionally stirred up controversy with his editorials to build up a stimulating Brass Tacks. Stanley Schmidt put himself on the line, representing the need for reflection we all share to be the people we would like to be, both as individuals and as U. S. Constitution-empowered, United States citizens. And you are going for the jugular, straight at the heart of the most fundamental kind of need to read. I am for it 100%. And I can see why you don't want to go to so much creative trouble for editorials every month.

But I am hoping for a little more frequency than we have at present as you come to like editing *Analog* more and more thoroughly. In fact, in the meantime, I'd be delighted to run into micro-editorials of yours, say one to three paragraphs in length, on timely if less momentous occasions or in connection with something you publish in the same issue or recent issues that is worth playing with so seriously. Despite the high quality and interest of all your guest editorials, this one is the single best editorial that you have published thus far, for me.

And I always read each issue in its entirety. That's what I subscribe for.

Joseph E. Quittner
Cleveland, OH ■

UPCOMING EVENTS Anthony Lewis

NOTE: Membership rates and other details often change after we have gone to press. In addition, most conventions have age-based membership rates in advance and at the door. There also may be rates for single days. Check the websites for the most recent information.

2-4 October 2015

ARCHON 39 (St. Louis MO area SF conference) at Gateway Convention Center and Doubletree by Hilton Collinsville, IL. Guest of Honor: Jacqueline Carey, Artist Guest of Honor: Brent Chumley, Filk Guest of Honor: Tricky Pixie, Media Guest of Honor: RJ Haddy, Science Guest of Honor: Jordin T. Kare; TM: Esther Friesner, Masquerade MC: Victor Milan. Memberships: Advance rates good until 31 July 2015/at the door. Adult (\$55/\$70); YA 17-20 (\$30/\$30); Youth 11-16 (\$20/\$20); Child 6-10 (\$8/\$8). Info: <http://www.archonstl.org/>.

2-4 October 2015

VCON 40 (Vancouver, BC area SF conference) at Sheraton Vancouver Airport Hotel, Richmond, BC. Author Guest of Honor: Joe Haldeman; Game Design Guest of Honor: Ed Greenwood; Artist Guest of Honor: Rick Sternbach; Editor Guest of Honor: Eric Choi; Fan Guest of Honor: Steve Forty; MC: Spider Robinson. Memberships until 15 September 2015: Adult CAD40; Student/Senior (65+) CAD30; Youth (7-18) CAD20. Info: <http://www.vcon.ca/>.

9-11 October 2015

CONCLAVE 39 (Detroit area SF conference) at Doubletree by Hilton Detroit-Dearborn, Dearborn MI. Guest of Honor: Jody Lynn Nye. Info: <http://www.conclavesf.net/>; conclave@conclavesf.net; Conclave, Inc., c/o Barber, 2737 Colony Road, Ann Arbor, MI 48104.

9-11 October 2015

CAPCLAVE 2015 (DC area SF conference) at Hilton Washington DC North/Gaithersburg, Gaithersburg MD. Guests of Honor: Gordon Van Gelder, Alastair Reynolds. Membership: \$55 until 31 July; \$60 until 30 September; \$65 at the door. Info: <http://www.capclave.org/capclave/capclave15/>.

16-18 October 2015

ICON 40 (Iowa SF conference) at Cedar Rapids Doubletree, Cedar Rapids IA. Author Guest of Honor: David Gerrold; Artist Guest of Honor: Sarah Clemens; Author Guest of Honor: Ann Leckie; Cosplay Fan Guest of Honor: Kalli McCandless; TM: Jim C. Hines; Mama & Papa of ICON: Gay & Joe Haldeman. Registration: before 1 October: Adult \$45; Youth (7-12) \$25. At the door: Adult \$65; Youth \$35. Info: <http://www.iowa-icon.com/>; 308 E Burlington St 300, Iowa City, IA 52240.

16-18 October 2015

CON†STELLATION XXXIII: Coma Berenices (Alabama area SF conference) at Four Points by Sheraton Huntsville Airport, Huntsville AL. Guest of Honor: Orson Scott Card. Info: http://www.con-stellation.org/constell/wiki/index.php?title=Con%E2%80%A0Stellation_Main_Page; constell@con-stellation.org; PO Box 4857, Huntsville AL 35815-4857; Google Voice-mail 256-270-0092.

23-25 October 2015

MILEHICON 47 (Colorado SF conference) at Hyatt Regency Hotel-Tech Center, Denver CO. Author Guest of Honor: Kevin Hearne; Artist Guest of Honor: Ursula Vernon; Author Guest of Honor: Kristine Kathryn Rusch; TM: James Van Pelt. Info: <http://www.milehicon.org/index.html>; info@milehicon.org.

30 October-1 November 2015

CAN-CON 2015 (The Conference on Canadian Content in Speculative Arts and Literature) at Sheraton Ottawa, Ottawa ON. Editor Guest of Honor: Trevor Quachri (*Analog* editor, yay!!). Info: <http://can-con.org/cc/>.

30 October-1 November 2015

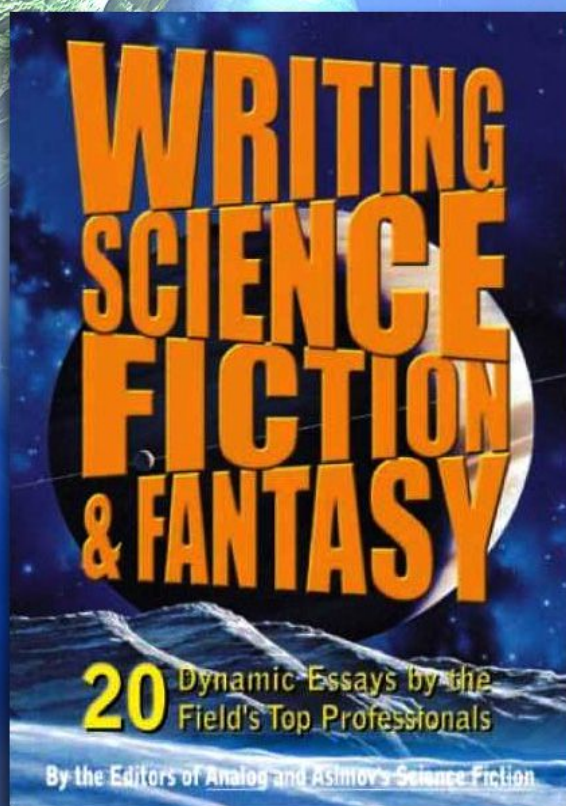
TUSCON 42 (Tucson area SF conference) at Hotel Tucson City Center InnSuites, Tucson AZ. Author Guest of Honor: Seanan McGuire/Mira Grant; Artist Guest of Honor: Bridget E. Wilde; TM: Ed Bryant. Info: <http://www.tusconscificon.com/>; basfa@earthlink.net; BASFA, PO Box 2528, Tucson AZ 85702-2528. ■

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